UNIWERSYTET
MIKOŁAJA KOPERNIKA
W TORUNIU

Collegium Medicum
im. Ludwika Rydygiera w Bydgoszczy

Bydgoszcz 2026 r.

UNIWERSYTET
MIKOŁAJA KOPERNIKA
W TORUNIU
Wydział Lekarski
Collegium Medicum w Bydgoszczy

Paweł Lipowski

Wpływ radioterapii i strategii płynoterapii na powikłania pooperacyjne u pacjentów poddanych cystektomii radykalnej lub prostej

Rozprawa na stopień doktora nauk medycznych i nauk o zdrowiu

Promotor:
Dr hab. n. med. Kajetan Juszczak, prof. UMK

Promotor pomocniczy:
Dr n. med. Adam Ostrowski

Bydgoszcz 2026

Serdeczne podziękowania

dla mojego promotora

Dr hab. n. med. Kajetana Juszczaka, prof. UMK

promotora pomocniczego
Dr n. med. Adama Ostrowskiego

oraz

zespołu Kliniki Urologii Ogólnej i Onkologicznej
Szpitala Uniwersyteckiego Nr. 1 im. dr A. Jurasza w Bydgoszczy
pod kierownictwem
prof. dr hab. n. med. Tomasza Drewy

Dziękuję

Spis treści

1. Wykaz publikacji stanowiących rozprawę doktorską

Publikacja 1.

Lipowski P, Ostrowski A, Adamowicz J, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy? *Cancers* 2025; 17(1):102. doi.org/10.3390/cancers17010102

Współczynnik wpływu (IF) = 4,4 Punktacja MNiE = 140

Publikacja 2.

Lipowski P, Ostrowski A, Adamowicz J, Kowalski F, Drewa T, Juszczak K. Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review. Cancers, 2025; 17(11): 1746. doi: 10.3390/cancers17111746.

Współczynnik wpływu (IF) = 4,4 Punktacja MNiE = 140

Publikacja 3.

Lipowski P, Ostrowski A, Adamowicz J, Zaigrajewa A, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026; Issue: Ahead of print Published on-line:Feb 22, 2026 doi: 10.5173/ceju.2025.0163

Współczynnik wpływu (IF) = 1,9 Punktacja MNiE = 70 pkt

Sumaryczna wartość punktowa IF = 10,7

Sumaryczna wartość punktowa MNiE = 350

2. Wykaz stosowanych skrótów

adjVBFI – adjusted Vascular Bed Filling Index (skorygowany wskaźnik wypełnienia łożyska naczyniowego)

aVBFI – adjusted Vascular Bed Filling Index (wskaźnik napełnienia łożyska naczyniowego uwzględniający utratę krwi i czas operacji)

BMI – Body Mass Index (wskaźnik masy ciała)

CD – Clavien–Dindo (skala klasyfikacji powikłań pooperacyjnych)

CEJU – Central European Journal of Urology

cT – clinical Tumor stage (kliniczne zaawansowanie guza)

EAU – European Association of Urology (Europejskie Towarzystwo Urologiczne)

ERAS – Enhanced Recovery After Surgery (protokół przyspieszonego powrotu do zdrowia po zabiegu)

GDFT – Goal-Directed Fluid Therapy (płynoterapia celowana)

IC – ileal conduit (odprowadzenie moczu metodą wstawki jelitowej)

IF – Impact Factor (współczynnik wpływu)

KKCz – koncentrat krwinek czerwonych

MIBC – Muscle-Invasive Bladder Cancer (rak pęcherza moczowego naciekający mięśniówkę)

MEiN – Ministerstwo Edukacji i Nauki

NMIBC – Non–Muscle-Invasive Bladder Cancer (rak pęcherza moczowego nienaciekający mięśniówki)

OIT – Oddział Intensywnej Terapii

PSM – Propensity Score Matching (dopasowanie wyników na podstawie skłonności)

RC – Radical Cystectomy (cystektomia radykalna)

RT – Radiotherapy (radioterapia)

SC – Simple Cystectomy (cystektomia prosta)

TPN – Total Parenteral Nutrition (całkowite żywienie pozajelitowe)

UCS – ureterocutaneostomy (ureterokutanostomia)

VBFI – Vascular Bed Filling Index (wskaźnik wypełnienia łożyska naczyniowego)

WJ Urol – World Journal of Urology

3. Streszczenie w języku polskim

Radykalna cystektomia pozostaje złotym standardem leczenia raka pęcherza moczowego naciekającego błonę mięśniową oraz wybranych przypadków raka nienaciekającego. Mimo postępów w technikach chirurgicznych i wdrożenia protokołów okołozabiegowych, zabieg ten nadal charakteryzuje się wysokim odsetkiem powikłań, dochodzącym do 42% dla powikłań ciężkich według klasyfikacji Clavien-Dindo. Jednym z najważniejszych, a jednocześnie modyfikowalnych elementów opieki okołooperacyjnej jest strategia płynoterapii, która może wpływać zarówno na hemodynamikę śródoperacyjną, jak i na występowanie powikłań pooperacyjnych. Równocześnie istotnym problemem klinicznym są przypadki wymagające usunięcia pęcherza moczowego po przebytym napromienianiu w obrębie miednicy. U tej grupy obserwuje się istotne zaburzenia gojenia tkanek i uszkodzenia popromienne, co zwiększa ryzyko powikłań pooperacyjnych. Ponadto u części chorych z powodu ciężkiej dysfunkcji pęcherza moczowego i/lub obecności przetok pęcherzowych konieczne jest wykonanie cystektomii prostej. Dotychczasowa literatura dotycząca tego zagadnienia jest ograniczona, a brak badań porównawczych utrudnia ocenę rzeczywistego ryzyka chirurgicznego w tej grupie chorych.

Dlatego też celem niniejszej rozprawy była ocena wpływu strategii płynoterapii i napełnienia łożyska naczyniowego na ryzyko powikłań po cystektomii radykalnej u pacjentów z rakiem pęcherza moczowego oraz analiza strategii płynoterapii opisanych w literaturze. Ponadto oceniono wpływ radioterapii na powikłania pooperacyjne w grupie pacjentów poddanych cystektomii prostej.

Realizację celu przeprowadzono poprzez cykl 3 publikacji stanowiących trzon rozprawy. W badaniu pierwszym oceniono zależność między podażą płynów, wskaźnikami hemodynamicznymi VBFI i aVBFI, odprowadzeniem moczu a powikłaniami po cystektomii radykalnej u 288 chorych, wykazując większą wartość predykcyjną parametrów hemodynamicznych niż łącznej objętości przetoczonych płynów. W publikacji nr 2 dokonano systematycznego przeglądu literatury obejmującego 17 badań analizujących wpływ strategii płynoterapii na wyniki okołooperacyjne, wskazując na korzyści płynoterapii restrykcyjnej wspomaganej wazopresorami oraz częściową skuteczność terapii celowanej (GDFT). Publikacja nr 3 obejmowała analizę dwóch grup składających się łącznie z 257 pacjentów poddanych cystektomii prostej z powodu uszkodzeń popromiennych oraz cystektomii radykalnej z przyczyn onkologicznych. Uzyskane wyniki wykazały istotnie gorsze wyniki pooperacyjne w grupie cystektomii prostej, w tym większy odsetek powikłań, wyższą częstość reoperacji, częstsze stosowanie żywienia pozajelitowego oraz dłuższą hospitalizację w

porównaniu z pacjentami bez radioterapii.

Wnioski uzyskane w ramach rozprawy wskazują, że sama objętość podaży płynów nie przekłada się na powikłania pooperacyjne, a wskaźniki VBFI i aVBFI mogą stanowić pomocne narzędzie do oceny napełnienia łożyska naczyniowego i zarządzania płynoterapią w trakcie zabiegu operacyjnego. Dostępne dane literaturowe sugerują przewagę strategii restrykcyjnej z zastosowaniem wazopresorów, choć brak jest jednoznacznych dowodów pozwalających na sformułowanie jednolitych rekomendacji. Wyniki dotyczące cystektomii prostej potwierdzają, że przebyta radioterapia wiąże się z istotnie większym ryzykiem powikłań, co powinno być uwzględniane podczas kwalifikacji do zabiegu. Przedstawione badania podkreślają konieczność indywidualizacji płynoterapii oraz dalszego doskonalenia strategii okołooperacyjnych w celu ograniczenia powikłań po zabiegu usunięcia pęcherza moczowego z przyczyn onkologicznych (cystektomia radykalna) lub nieonkologicznych (cystektomia prosta).

4. Streszczenie w języku angielskim

Radical cystectomy remains the gold standard treatment for muscle-invasive bladder cancer as well as for selected cases of high-risk non-muscle-invasive disease. Despite advances in surgical techniques and the implementation of perioperative care protocols, the procedure continues to be associated with a high rate of complications, reaching up to 42% for severe complications according to the Clavien–Dindo classification. One of the most important yet modifiable components of perioperative management is fluid therapy strategy, which may influence both intraoperative haemodynamics and the occurrence of postoperative complications. At the same time, an important clinical challenge is represented by patients requiring bladder removal following prior pelvic irradiation. In this population, significant impairment of tissue healing and radiation-induced damage is observed, leading to an increased risk of postoperative morbidity. Furthermore, in a subset of patients, severe bladder dysfunction and/or the presence of vesical fistulas necessitate simple cystectomy. The available literature addressing this issue remains limited, and the lack of comparative studies makes it difficult to accurately estimate surgical risk in this patient group.

The aim of the present dissertation was to evaluate the impact of perioperative fluid management strategies and vascular bed filling on postoperative complications following radical cystectomy in patients with bladder cancer, and to analyse fluid therapy strategies described in the literature. In addition, the effect of prior radiotherapy on postoperative outcomes in patients undergoing simple cystectomy was assessed. The objectives were achieved through a series of three publications forming the core of the thesis. The first study evaluated the relationship between fluid administration, haemodynamic indices (VBFI and aVBFI), urinary diversion type, and postoperative complications in 288 patients undergoing radical cystectomy, demonstrating a greater predictive value of haemodynamic parameters compared with the total volume of administered fluids. The second publication presented a systematic review of 17 studies analysing perioperative fluid strategies, indicating benefits of restrictive fluid therapy supported by vasopressors and partial effectiveness of goal-directed fluid therapy (GDFT). The third publication analysed two groups comprising a total of 257 patients undergoing simple cystectomy for radiation-induced bladder injury and radical cystectomy for oncological indications. The results demonstrated significantly worse postoperative outcomes in the simple cystectomy group, including a higher complication rate, increased frequency of reoperations, greater need for total parenteral nutrition, and longer hospitalization compared with patients without prior radiotherapy.

The findings of the dissertation indicate that the total volume of administered fluids alone does not directly correlate with postoperative complications, whereas VBFI and aVBFI may serve as useful tools for assessing vascular bed filling and guiding intraoperative fluid management. Available evidence suggests an advantage of restrictive strategies supported by vasopressors, although current data remain insufficient to establish uniform clinical recommendations. Outcomes following simple cystectomy confirm that prior radiotherapy is associated with a significantly increased risk of postoperative complications and should be carefully considered during surgical qualification. The presented studies highlight the need for individualized fluid management and further optimization of perioperative strategies to reduce morbidity following bladder removal performed for oncological (radical cystectomy) or non-oncological (simple cystectomy) indications.

5. Omówienie rozprawy doktorskiej

5.1. Wstęp

Znaczenie cystektomii radykalnej i jej powikłania

Radykalne usunięcie pęcherza moczowego stanowi podstawową metodę leczenia raka pęcherza naciekającego błonę mięśniową (MIBC) oraz wybranych przypadków nowotworów nienaciekających o bardzo wysokim ryzyku progresji, zgodnie z obowiązującymi wytycznymi Europejskiego Towarzystwa Urologicznego (EAU). Nowotwór ten cechuje się agresywnym przebiegiem klinicznym, częstą progresją i dużym ryzykiem rozsiewu, co sprawia, że leczenie chirurgiczne pozostaje kluczowym elementem postępowania terapeutycznego.

Cystektomia radykalna obejmuje usunięcie pęcherza moczowego wraz z regionalnymi węzłami chłonnymi, a u mężczyzn dodatkowo prostaty i pęcherzyków nasiennych, natomiast u kobiet macicy, jajowodów, jajników i przedniej ściany pochwy. Integralną częścią zabiegu cystektomii jest jednoczesne wytworzenie odprowadzenia moczu. Ten rozległy zabieg operacyjny wiąże się ze znaczącymi wskaźnikami śmiertelności i powikłań. Śmiertelność w ciągu 30 dni wynosi do 3,2% i do 8,0% w ciągu 90 dni od zabiegu (1-2). Wskaźnik ciężkich powikłań Grade ≥ III w skali Clavien-Dindo dochodzi do 42% (3-6)**.** Dominującymi problemami są niedrożność porażenna jelit, zakażenia, powikłania septyczne, powikłania nerkowe oraz krwawienia wymagające interwencji. Istotnym elementem postępowania pooperacyjnego pozostaje również ryzyko powikłań jelitowych związanych z wykorzystaniem fragmentu jelita do rekonstrukcji dróg moczowych (7-8). Różnice w częstości powikłań obserwowane między ureterocutaneostomią a jelitowymi sposobami odprowadzenia moczu dodatkowo podkreślają złożoność decyzji terapeutycznych w tej grupie chorych (9)**.**

Znaczenie płynoterapii

Płynoterapia dożylna stanowi jeden z kluczowych elementów opieki okołooperacyjnej u chorych poddawanych dużym zabiegom w obrębie miednicy, takich jak cystektomia radykalna. Jej głównym celem jest utrzymanie stabilności hemodynamicznej oraz prawidłowej równowagi wodno-elektrolitowej, co przekłada się na właściwą perfuzję narządów i sprawne gojenie tkanek. Nadal nie określono jednak jednoznacznie optymalnej objętości płynów

podawanych w trakcie i po operacji cystektomii radykalnej. Dotychczasowe badania sugerują, że zarówno niedobór, jak i nadmierna podaż płynów mogą zwiększać ryzyko powikłań, a całkowita ilość płynów w dniu zabiegu nie powinna przekraczać 3 litrów (10).

Wykazano, że spersonalizowana, umiarkowanie restrykcyjna płynoterapia może skracać czas trwania pooperacyjnej niedrożności porażennej i zmniejszać częstość powikłań (11). Szczególnie korzystne efekty obserwuje się w ramach protokołów Enhanced Recovery After Surgery (ERAS), które opierają się m.in. na oszczędnej płynoterapii, wczesnej mobilizacji i redukcji stresu operacyjnego. Zastosowanie ERAS w cystektomii radykalnej prowadzi do krótszej hospitalizacji, szybszego powrotu funkcji jelit (12-13).

Brak jednak jednoznacznych danych pozwalających wskazać najlepszą strategię dla pacjentów poddawanych cystektomii radykalnej. Złożoność zabiegu, duże obciążenie metaboliczne oraz wysoka częstość powikłań sprawiają, że właściwa płynoterapia stanowi jeden z najważniejszych, ale wciąż niedostatecznie poznanych aspektów opieki okołooperacyjnej.

Znaczenie radioterapii i jej powikłania

Radioterapia miednicy stanowi istotny element leczenia raka prostaty, szyjki macicy, endometrium oraz nowotworów odbytnicy i pozostaje jedną z najczęściej stosowanych metod leczenia radykalnego lub uzupełniającego w onkologii. Radioterapia cechuje się wysokim profilem bezpieczeństwa (14). Mimo to u części pacjentów dochodzi do wystąpienia późnych powikłań popromiennych, które mogą pojawiać się po wielu miesiącach lub nawet latach od zakończenia terapii. Do takich powikłań należą popromienna dysfunkcja pęcherza moczowego oraz przetoki pęcherzowo-jelitowe, które, choć rzadkie, dotyczą około 0,2% pacjentów leczonych radioterapią z powodu raka prostaty (15-16). Ze względu na ich pogarszający funkcjonowanie i jakość życia charakter stanowią one istotny problem kliniczny.

Patofizjologia uszkodzeń popromiennych obejmuje przewlekły proces zapalny, stres oksydacyjny, postępujące włóknienie oraz redukcję gęstości naczyń włosowatych (17-18) Zmiany te prowadzą do niedokrwienia, zaburzeń gojenia i zwiększonej kruchości tkanek, a w konsekwencji do powstawania owrzodzeń, krwawień, martwicy oraz perforacji. Upośledzona angiogeneza i martwicze zmiany w ścianie pęcherza i jelita znacząco ograniczają zdolność tkanek do regeneracji i stanowią główną przyczynę ciężkiego przebiegu powikłań popromiennych (19).

Z tego względu leczenie operacyjne pacjentów uprzednio napromienianych stanowi szczególne wyzwanie. Zabiegi wykonywane w polu napromienianym obarczone są wyższymi wskaźnikami infekcji, rozejścia ran, zaburzeń gojenia oraz koniecznością rewizji chirurgicznych, co potwierdzono zarówno w urologii, jak i w innych dziedzinach chirurgii rekonstrukcyjnej (20-21). Zmiany popromienne prowadzą do trudniejszych preparacji tkanek, gorszej kontroli hemostazy oraz większego ryzyka powikłań pooperacyjnych, co czyni tę grupę chorych szczególnie narażoną na niekorzystny przebieg okołooperacyjny.

Cystektomia prosta po radioterapii

Cystektomia prosta jest stosunkowo rzadkim zabiegiem, wykonywanym przede wszystkim u pacjentów z ciężką, oporną na leczenie popromienną dysfunkcją pęcherza, obejmującą nawracające krwotoczne zapalenie pęcherza moczowego, przewlekły ból oraz powikłania takie jak przetoki pęcherzowo-jelitowe (22). Mimo mniejszego zakresu anatomicznego w porównaniu z cystektomią radykalną, zabieg ten należy do technicznie wymagających, głównie z uwagi na znaczne włóknienie, zmniejszoną elastyczność tkanek oraz zaburzenia ukrwienia wynikające z wcześniejszej radioterapii (23). Zmiany te powodują utrudnione preparowanie, zwiększone ryzyko krwawienia, wycieku moczu oraz konieczności rewizji chirurgicznych, co przekłada się na wysoki odsetek powikłań pooperacyjnych (24). Dodatkową trudność stanowi często współwystępujący stan zapalny oraz deformacja anatomiczna pęcherza, które mogą utrudniać zarówno usunięcie narządu, jak i wykonanie odprowadzenia moczu.

Dane dotyczące wyników cystektomii prostej w populacji pacjentów z popromiennymi uszkodzeniami pęcherza są skąpe. Większość publikacji dotyczących cystektomii koncentruje się natomiast na populacji onkologicznej, co utrudnia bezpośrednie odniesienie wyników do pacjentów z uszkodzeniem popromiennym. Brak większych badań porównawczych oraz heterogeniczność dostępnych danych sprawiają, że rzeczywiste ryzyko okołooperacyjne, czynniki prognostyczne oraz optymalne podejście chirurgiczne w tej grupie chorych nadal pozostają nie w pełni poznane.

5.2. Cel badań

Głównym celem przeprowadzonych badań była ocena wpływu radioterapii i strategii płynoterapii na powikłania pooperacyjne u pacjentów poddanych cystektomii radykalnej lub prostej. Przeprowadzono analizę wpływu objętości płynów podawanych dożylnie podczas cystektomii radykalnej na częstość i charakter powikłań pooperacyjnych z uwzględnieniem typu odprowadzenia moczu. Uzupełnieniem tych badań był systematyczny przegląd piśmiennictwa dotyczącego strategii płynoterapii w cystektomii. Dodatkowo oceniono wpływ radioterapii na ryzyko powikłań po cystektomii prostej wykonanej u chorych z popromienną dysfunkcją pęcherza moczowego.

Cele szczegółowe

1. Ocena związku pomiędzy objętością podanych (śródzabiegowo) dożylnie płynów i w połączeniu ze sposobem odprowadzenia moczu a powikłaniami w 30 i 90 dobie po cystektomii radykalnej.
2. Zdefiniowanie nowych parametrów klinicznych w aspekcie płynoterapii śródzabiegowej i dodatkowego narzędzia oceny ryzyka powikłań pooperacyjnych (wskaźnik VBFI i aVBFI).
3. Porównanie powikłań pooperacyjnych u pacjentów poddanych cystektomii prostej z powodu popromiennej dysfunkcji pęcherza moczowego z wynikami pacjentów poddanych cystektomii radykalnej.
4. Określenie czy grupa chorych z popromienną dysfunkcją pęcherza moczowego poddanych cystektomii prostej stanowi grupę szczególnie wysokiego ryzyka powikłań.

5.3. Materiały i metody

W niniejszym podrozdziale zaprezentowano zarys metodyki przeprowadzonych badań. Szczegółowy opis zawarto w załączonych publikacjach.

Publikacja 1

Lipowski P, Ostrowski A, Adamowicz J, Kowalski F, Drewa T, Juszczak K.
Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review. Cancers, 2025; 17(11): 1746.
doi: 10.3390/cancers17111746.

W publikacji 1 wykonano systematyczny przegląd piśmiennictwa zgodny z wytycznymi PRISMA 2020, obejmujący badania oceniające strategie płynoterapii okołooperacyjnej w cystektomii radykalnej. Przeszukano bazę PubMed w styczniu 2025 roku, stosując predefiniowane słowa kluczowe dotyczące cystektomii radykalnej, płynoterapii oraz powikłań pooperacyjnych. Do analizy włączono 17 badań, w tym 8 randomizowanych i 9 obserwacyjnych, po uprzedniej selekcji tytułów, streszczeń i pełnych tekstów. Z każdego badania pozyskano dane dotyczące rodzaju interwencji płynowych, typu zabiegu, elementów protokołu ERAS oraz najważniejszych punktów końcowych. Przeprowadzono narracyjną syntezę danych z uwagi na heterogeniczność populacji i metod. Wyniki miały na celu określenie aktualnego stanu wiedzy oraz identyfikację luk dotyczących optymalnej płynoterapii podczas cystektomii radykalnej.

Publikacja 2

Lipowski P, Ostrowski A, Adamowicz J, Jasiewicz P, Kowalski F, Drewa T, Juszczak K.
Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy? *Cancers* 2025; 17(1):102.
https://doi.org/10.3390/cancers17010102

W publikacji 2 przeprowadzono retrospektywną analizę 288 pacjentów poddanych laparoskopowej cystektomii radykalnej z odprowadzeniem moczu w postaci ureterocutaneostomii lub wstawki jelitowej. Analizie poddano ilość płynów podanych w okresie okołooperacyjnym oraz wskaźniki hemodynamiczne określające napełnienie łożyska naczyniowego, takie jak VBFI i aVBFI uwzględniające utratę krwi oraz czas zabiegu

operacyjnego. Zbierano dane demograficzne, kliniczne oraz dotyczące powikłań pooperacyjnych w okresie 30 i 90 dni według klasyfikacji Clavien–Dindo. Uwzględniono również wpływ czasu operacji, BMI i rodzaju odprowadzenia moczu na częstość powikłań. Analizy statystyczne obejmowały testy nieparametryczne, modele regresji oraz analizę porównawczą między grupami. Wyniki posłużyły do oceny wpływu płynoterapii na wyniki pooperacyjne u chorych poddawanych radykalnej cystektomii.

Publikacja 3

Lipowski P, Ostrowski A, Adamowicz J, Zaigrajewa A, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction
compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026;
Issue: Ahead of print Published on-line:Feb 22, 2026
doi: 10.5173/ceju.2025.0163

W publikacji 3 przeanalizowano retrospektywną kohortę 257 pacjentów, w tym 25 operowanych z powodu popromiennej dysfunkcji pęcherza (cystektomia prosta) oraz 232 poddanych cystektomii radykalnej z powodu raka pęcherza moczowego. Wszystkie operacje wykonano laparoskopowo, u wszystkich chorych zastosowano jednolity sposób odprowadzenia moczu w postaci ureterocutaneostomii. Zastosowano zaawansowaną metodę propensity score matching w celu dopasowania pacjentów wg istotnych zmiennych klinicznych, w trzech niezależnych analizach: 1) z RC cT1–T2, 2) z RC cT3–T4 oraz 3) z podgrupą pacjentów z przetoką pęcherzową. Zbierano dane dotyczące powikłań pooperacyjnych w 30 i 90 dni, reoperacji, czasu hospitalizacji, transfuzji i przyjęć na OIT. Analizy obejmowały testy nieparametryczne, modele logistyczne oraz ocenę równowagi zmiennych po dopasowaniu.

5.4. Podsumowanie wyników

Publikacja 1

Lipowski P, Ostrowski A, Adamowicz J, Kowalski F, Drewa T, Juszczak K.
Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review. Cancers, 2025; 17(11): 1746.
doi: 10.3390/cancers17111746.

W publikacji 1 przeprowadzono systematyczny przegląd literatury obejmujący 17 badań oceniających wpływ różnych strategii płynoterapii okołooperacyjnej na wyniki leczenia pacjentów poddawanych cystektomii radykalnej. Analiza wykazała, że strategie restrykcyjne, zwłaszcza w połączeniu z zastosowaniem wazopresorów, mogą przyczyniać się do zmniejszenia częstości powikłań, ograniczenia utraty krwi oraz skrócenia hospitalizacji. W badaniach opartych na płynoterapii celowanej (GDFT) odnotowano redukcję powikłań jelitowych, takich jak niedrożność porażenna, jednak efekty dotyczące czasu hospitalizacji czy funkcji nerek pozostawały niejednoznaczne. Autorzy zwrócili uwagę na znaczną heterogeniczność uwzględnionych protokołów, metod monitorowania hemodynamiki oraz populacji chorych, co uniemożliwiło przeprowadzenie metaanalizy ilościowej. Uzyskane wyniki podkreślają kliniczne znaczenie optymalizacji płynoterapii, jednocześnie wskazując na potrzebę dalszych badań porównawczych.

Publikacja 2.

Lipowski P, Ostrowski A, Adamowicz J, Jasiewicz P, Kowalski F, Drewa T, Juszczak K.
Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy? *Cancers* 2025; 17(1):102.
https://doi.org/10.3390/cancers17010102

W publikacji 2 oceniono wpływ podaży płynów dożylnych na wyniki okołooperacyjne u 288 chorych, którzy przeszli laparoskopową cystektomię radykalną. Analiza danych wykazała, że całkowita objętość płynów podawanych w trakcie zabiegu korelowała z liczbą powikłań, jednak zależność ta nie osiągała istotności statystycznej po uwzględnieniu czasu trwania operacji czy BMI.

W analizie zaproponowano dwa autorskie wskaźniki służące do bardziej precyzyjnej oceny płynoterapii śródoperacyjnej: aVBFI (absolute Vascular Bed Filling Index) oraz adjVBFI

(adjusted Vascular Bed Filling Index)**.** Zostały one opracowane, ponieważ sama całkowita objętość podanych płynów nie uwzględnia różnic w utracie krwi ani w czasie trwania operacji, co utrudnia porównywanie pacjentów między sobą.

Wskaźnik aVBFI określa relację między ilością podanych płynów a utratą krwi śródoperacyjnej. Innymi słowy, pokazuje, w jakim stopniu podaż płynów kompensowała krwawienie podczas zabiegu. Wyższa wartość aVBFI oznacza, że w stosunku do utraty krwi podano relatywnie więcej płynów, natomiast niższa wartość może wskazywać na mniejszą kompensację objętościową. Dzięki temu wskaźnik ten lepiej odzwierciedla rzeczywiste wypełnienie łożyska naczyniowego niż sama suma przetoczonych płynów.

Z kolei adjVFBI stanowi rozwinięcie aVBFI i dodatkowo uwzględnia czas trwania operacji. W praktyce pozwala to odróżnić sytuacje, w których podobna relacja płynów do utraty krwi występowała w krótkim lub bardzo długim zabiegu. Uwzględnienie czasu operacji ma istotne znaczenie, ponieważ dłuższy zabieg wiąże się z większym obciążeniem hemodynamicznym i metabolicznym organizmu. W ten sposób adjVFBI stanowi bardziej znormalizowaną miarę płynoterapii śródoperacyjnej.

Kluczowym wynikiem była obecność istotnej interakcji między wartością aVBFI a typem odprowadzenia moczu (UCS vs IC) (B = 0,07; p = 0,011). W zakresie wartości aVBFI od 0 do 8 metoda ureterocutaneostomii wiązała się z mniejszym ryzykiem powikłań niż odprowadzenie jelitowe, natomiast przy aVBFI równym 8 różnice między obiema metodami praktycznie zanikały. Wartości aVBFI powyżej 8 odwracały tę relację — w tej sytuacji odprowadzenie jelitowe było związane z mniejszą liczbą powikłań w ciągu 30 dni po zabiegu niż ureterocutaneostomia.

Podobny charakter zależności uzyskano dla skorygowanego wskaźnika adjVBFI, który również wykazywał istotną korelację zarówno z ciężkością powikłań (*B = −0.27; 95% CI: −0,45 do −0,08; p = 0,005*), jak i z rodzajem odprowadzenia moczu (*B = 0,24; 95% CI: 0,06 do 0,43; p = 0,011*).

Wyniki pracy podkreślają, że tradycyjna analiza sumarycznej ilości podanych płynów może być niewystarczająca, a złożone parametry hemodynamiczne mają potencjał, aby stać się bardziej wiarygodnymi narzędziami klinicznymi w opiece okołooperacyjnej nad pacjentami poddawanymi cystektomii radykalnej.

Publikacja 3.

Lipowski P, Ostrowski A, Adamowicz J, Zaigrajewa A, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026;

Issue: Ahead of print Published on-line:Feb 22, 2026

doi: 10.5173/ceju.2025.0163

W publikacji 3 porównano wyniki pooperacyjne cystektomii prostej (SC) wykonywanej z powodu popromiennej dysfunkcji pęcherza z wynikami cystektomii radykalnej (RC), analizując 257 pacjentów w trzech etapach: przed dopasowaniem, po propensity score matching (PSM) dla guzów cT1–T2, cT3–T4 oraz w podgrupie chorych z przetoką pęcherzową. Przed dopasowaniem pacjenci po cystektomii prostej istotnie częściej doświadczali ciężkich powikłań stopień 3 wg skali Clavien-Dindo (44% vs. 22,4%, $p < 0,001$), częściej wymagali reoperacji (47,8% vs. 11,6%, $p < 0,001$), żywienia pozajelitowego (36% vs. 9,9%, $p = 0,001$) oraz masywnych transfuzji ≥ 3j. KKCz (36% vs. 6,1%, $p < 0,001$), mimo że RC częściej wymagała transfuzji ogółem (77,5% vs. 52%, $p < 0,001$). Po dopasowaniu dla cT1–T2 stwierdzono tendencję do częstszych powikłań ciężkich w grupie SC (47,1% vs. 11,8%, $p = 0,057$), jednoznacznie wyższe ryzyko reoperacji (56,2% vs. 5,9%, $p = 0,002$), częstsze stosowanie żywienia pozajelitowego (41,2% vs. 5,9%, $p = 0,039$) oraz częstsze masywne transfuzje (41,2% vs. 5,9%, $p = 0,039$), przy jednocześnie częstszej potrzebie transfuzji KKCz w grupie cystektomii radykalnej (88,2% vs. 44,1%, $p = 0,026$); pacjenci po SC wymagali również znacznie dłuższej hospitalizacji (18 vs. 8 dni, $p < 0,001$). W analizie cT3–T4 nie obserwowano istotnych różnic w powikłaniach pooperacyjnych w okresie 30 dni ($p = 0,06$) ani 90 dni ($p = 0,773$). W podgrupie pacjentów z przetoką, po dopasowaniu kardynalnym (15 par), SC wiązała się z wyższym odsetkiem powikłań w stopniu 3 wg skali C-D (53,3% vs. 40,0%), choć ogólna różnica w skali CD nie osiągnęła istotności statystycznej ($p = 0,130$). Jednocześnie odsetek reoperacji był istotnie wyższy w grupie SC (61,5% vs. 6,7%; $p = 0,004$), a większe zapotrzebowanie na TPN (40,0% vs. 13,3%; $p = 0,215$) i częstsze przyjęcia na OIT (30,8% vs. 6,7%; $p = 0,153$) potwierdzały cięższy przebieg pooperacyjny.

5.5. Wnioski

1. Sama objętość przetoczonych płynów nie stanowi niezależnego predyktora powikłań po cystektomii radykalnej. Większą wartość kliniczną mają nowo opracowane wskaźniki hemodynamiczne takie jak VBFI i aVBFI.
2. Zależność między parametrami napełnienia łożyska naczyniowego a ryzykiem powikłań różni się w zależności od typu odprowadzenia moczu i ma większy wpływ na nasilenie powikłań pooperacyjnych przy użyciu wstawki jelitowej.
3. Dostępne dane literaturowe potwierdzają korzyści restrykcyjnej płynoterapii wspomaganej wazopresorami w redukcji powikłań po cystektomii radykalnej.
4. Cystektomia prosta wykonywana z powodu popromiennej dysfunkcji pęcherza wiąże się z istotnie wyższym odsetkiem powikłań i częstszą koniecznością reoperacji niż cystektomia radykalna.
5. Przebyta radioterapia jest kluczowym czynnikiem zwiększającym ryzyko powikłań pooperacyjnych i powinna być uwzględniana przy kwalifikacji do zabiegu usunięcia pęcherza moczowego.
6. U chorych poddawanych cystektomii prostej z powodu popromiennej dysfunkcji pęcherza należy rozważyć wykonanie prostego odprowadzenia moczu (ureterokutaneostomii) w celu zmniejszenia ryzyka powikłań.

6. Piśmiennictwo

1. Bochner BH, Dalbagni G, Sjoberg DD, Silberstein J, Keren Paz GE, Donat SMH, et al. Comparing Open Radical Cystectomy and Robot-assisted Laparoscopic Radical Cystectomy: A Randomized Clinical Trial. Eur Urol. 2015 Jun 1;67(6):1042–50. doi:10.1016/J.EURURO.2014.11.043 PubMed PMID: 25496767.
2. Mossanen M, Krasnow RE, Zlatev D V., Tan WS, Preston MA, Trinh QD, et al. Examining the relationship between complications and perioperative mortality following radical cystectomy: a population-based analysis. BJU Int. 2019 Jul 1;124(1):40–6. doi:10.1111/BJU.14636 PubMed PMID: 30499636.
3. Cicione A, de Nunzio C, Lombardo R, Trucchi A, Manno S, Lima E, et al. Complications and quality of life of ileal conduit, orthotopic neobladder and ureterocutaneostomy: systematic review of reports using the Clavien-Dindo Classification. Minerva Urol Nefrol. 2020 Aug 1;72(4):408–19. doi:10.23736/S0393-2249.20.03641-3 PubMed PMID: 32734749.
4. Haas M, Huber T, Pickl C, van Rhijn BWG, Gužvić M, Gierth M, et al. The comprehensive complication index is associated with a significant increase in complication severity between 30 and 90 days after radical cystectomy for bladder cancer. Eur J Surg Oncol. 2021 May 1;47(5):1163–71. doi:10.1016/J.EJSO.2020.09.040 PubMed PMID: 33046281.
5. Furrer MA, Huesler J, Fellmann A, Burkhard FC, Thalmann GN, Wuethrich PY. The Comprehensive Complication Index CCI: A proposed modification to optimize short-term complication reporting after cystectomy and urinary diversion. Urol Oncol. 2019 Apr 1;37(4):291.e9-291.e18. doi:10.1016/J.UROLONC.2018.12.013 PubMed PMID: 30638668.
6. Demaegd L, Albersen M, Muilwijk T, Milenkovic U, Moris L, Everaerts W, et al. Comparison of postoperative complications of ileal conduits versus orthotopic neobladders. Transl Androl Urol. 2020 Dec;9(6):2541–54. doi:10.21037/TAU-20-713)
7. Rezaee ME, Atwater BL, Bihrle W, Schroeck FR, Seigne JD. Ileal Conduit Versus Continent Urinary Diversion in Radical Cystectomy: A Retrospective Cohort Study of 30-day Complications, Readmissions, and Mortality. Urology. 2022 Dec 1;170:139–45. doi:10.1016/J.UROLOGY.2022.08.020 PubMed PMID: 36007686.
8. Izquierdo L, Bolton DM, Lawrentschuk N. Radical cystectomy and orthotopic bladder substitution: surgical tricks and management of complications. Minerva Urol Nefrol. 2013 Dec;65(4):225–34. PubMed PMID: 24091476.
9. Korkes F, Fernandes E, Gushiken FA, Glina FPA, Baccaglini W, Timóteo F, et al. Bricker ileal conduit vs. Cutaneous ureterostomy after radical cystectomy for bladder cancer: a systematic review. Int Braz J Urol. 2022 Jan 1;48(1):18–30. doi:10.1590/S1677-5538.IBJU.2020.0892 PubMed PMID: 33861058.
10. Schwenk W, Flemming S, Girona-Johannkämper M, Wendt W, Darwich I, Strey C. [Structured implementation of fast-track pathways to enhance recovery after elective colorectal resection : First results from five German hospitals]. Chirurgie (Heidelberg, Germany). 2024 Feb 1;95(2):148–56. doi:10.1007/S00104-023-01986-8 PubMed PMID: 37947802.
11. Gõmez-Izquierdo JC, Feldman LS, Carli F, Baldini G. Meta-analysis of the effect of goal-directed therapy on bowel function after abdominal surgery. British Journal of Surgery. John Wiley and Sons Ltd; 2015. p. 577–89. doi:10.1002/bjs.9747 PubMed PMID: 25759947.
12. Daneshmand S, Ahmadi H, Schuckman AK, Mitra AP, Cai J, Miranda G, et al. Enhanced recovery protocol after radical cystectomy for bladder cancer. Journal of Urology. 2014;192(1):50–6. doi:10.1016/j.juro.2014.01.097 PubMed PMID: 24518775.

13. Frees SK, Aning J, Black P, Struss W, Bell R, Chavez-Munoz C, et al. A prospective randomized pilot study evaluating an ERAS protocol versus a standard protocol for patients treated with radical cystectomy and urinary diversion for bladder cancer. World J Urol. 2018 Feb 1;36(2):215–20. doi:10.1007/s00345-017-2109-2 PubMed PMID: 29116394.
14. Matzinger O, Duclos F, Bergh A van den, Carrie C, Villà S, Kitsios P, et al. Acute toxicity of curative radiotherapy for intermediate- and high-risk localised prostate cancer in the EORTC trial 22991. Eur J Cancer. 2009 Nov;45(16):2825–34. doi:10.1016/J.EJCA.2009.07.009 PubMed PMID: 19682889.
15. Sadighian M, Hakam N, Amend G, Shaw NM, Tahir P, Allen IE, et al. Radiation-induced Fistulas in Patients With Prior Pelvic Radiotherapy for Prostate Cancer: A Systematic Review and Meta-analysis. Urology. 2023 Jun 1;176:121–6. doi:10.1016/J.UROLOGY.2023.03.015 PubMed PMID: 36963666.
16. Spratt DE, Pei X, Yamada J, Kollmeier MA, Cox B, Zelefsky MJ. Long-term survival and toxicity in patients treated with high-dose intensity modulated radiation therapy for localized prostate cancer. Int J Radiat Oncol Biol Phys. 2013 Mar 1;85(3):686–92. doi:10.1016/J.IJROBP.2012.05.023 PubMed PMID: 22795805.
17. Dormand EL, Banwell PE, Goodacre TEE. Radiotherapy and wound healing. Int Wound J. 2005;2(2):112–27. doi:10.1111/J.1742-4801.2005.00079.X PubMed PMID: 16722862.
18. Brossard C, Lefranc AC, Simon JM, Benderitter M, Milliat F, Chapel A. Understanding Molecular Mechanisms and Identifying Key Processes in Chronic Radiation Cystitis. International Journal of Molecular Sciences 2022, Vol 23, Page 1836. 2022 Feb 6;23(3):1836. doi:10.3390/IJMS23031836 PubMed PMID: 35163758.
19. Helissey C, Cavallero S, Brossard C, Dusaud M, Chargari C, François S. Chronic Inflammation and Radiation-Induced Cystitis: Molecular Background and Therapeutic Perspectives. Cells 2021, Vol 10, Page 21. 2020 Dec 24;10(1):21. doi:10.3390/CELLS10010021 PubMed PMID: 33374374.
20. Onoda S, Kimata Y, Sugiyama N, Onoda T, Mizukawa N. Effects of radiation therapy on postoperative complications and adverse events in patients with head and neck reconstruction with flaps. Microsurgery. 2014 Oct 1;34(7):516–21. doi:10.1002/MICR.22275 PubMed PMID: 24817499.
21. Potkrajcic V, Kolbenschlag J, Sachsenmaier S, Daigeler A, Ladurner R, Golf A, et al. Postoperative complications and oncologic outcomes after multimodal therapy of localized high risk soft tissue sarcoma. Radiation Oncology. 2022 Dec 1;17(1):1–11. doi:10.1186/S13014-022-02166-4/FIGURES/4 PubMed PMID: 36544149.
22. Mendenhall WM, Henderson RH, Costa JA, Hoppe BS, Dagan R, Bryant CM, et al. Hemorrhagic radiation cystitis. Am J Clin Oncol. 2015 Jun 9;38(3):331–6. doi:10.1097/COC.0000000000000016 PubMed PMID: 24322335.
23. Zwaans BMM, Wegner KA, Bartolone SN, Vezina CM, Chancellor MB, Lamb LE. Radiation cystitis modeling: A comparative study of bladder fibrosis radio-sensitivity in C57BL/6, C3H, and BALB/c mice. Physiol Rep. 2020 Feb 1;8(4):e14377. doi:10.14814/PHY2.14377 PubMed PMID: 32109348.
24. Gontero P, Pisano F, Palou J, Joniau S, Albersen M, Colombo R, et al. Complication rate after cystectomy following pelvic radiotherapy: an international, multicenter, retrospective series of 682 cases. World J Urol. 2020 Aug 1;38(8):1959–68. doi:10.1007/S00345-019-02982-6 PubMed PMID: 31691084.

7. Cykl publikacji stanowiących rozprawę doktorską

Publikacja 1

Lipowski P, Ostrowski A, Adamowicz J, Kowalski F, Drewa T, Juszczak K.

Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review. Cancers, 2025; 17(11): 1746.

doi: 10.3390/cancers17111746.

Publikacja 2

Lipowski P, Ostrowski A, Adamowicz J, Jasiewicz P, Kowalski F, Drewa T, Juszczak K.

Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy? *Cancers* 2025; 17(1):102.

doi: 10.3390/cancers17010102

Publikacja 3

Lipowski P, Ostrowski A, Adamowicz J, Zaigrajewa A, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction

compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026;

Issue: Ahead of print Published on-line:Feb 22, 2026

doi: 10.5173/ceju.2025.0163

7.1 Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review

cancers

MDPI

Systematic Review

Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review

Paweł Lipowski [1,*], Adam Ostrowski [1], Jan Adamowicz [1,2], Filip Kowalski [1], Tomasz Drewa [1] and Kajetan Juszczak [1,*]

[1] Department of Urology and Andrology, Collegium Medicum, Nicolaus Copernicus University, 85-094 Bydgoszcz, Poland; adostro@gmail.com (A.O.); adamowicz.jz@gmail.com (J.A.); urologpolska@gmail.com (F.K.); t.drewa@wp.pl (T.D.)

[2] Department of Regenerative Medicine, Collegium Medicum, Nicolaus Copernicus University, 85-094 Bydgoszcz, Poland

* Correspondence: pavelipovsky@gmail.com (P.L.); kaj.juszczak@gmail.com (K.J.)

Simple Summary: Fluid management during bladder cancer surgery can affect how much blood a patient loses, how quickly they recover, and whether complications occur. In this review, we looked at different ways of giving fluids during radical cystectomy, including limited (restrictive) fluids, personalized fluid therapy, and using warmed fluids. Some approaches, like limiting fluids and adjusting them based on the patient's condition, may help reduce blood loss and complications. However, the studies used different surgical techniques and protocols, which makes it hard to say which method works best. Some patients had robotic surgery, others had open surgery, and some had different ways of reconnecting the urinary system. More high-quality research is needed to better understand which fluid therapy is safest and most effective for patients having this major surgery.

Abstract: Background: Perioperative fluid management plays a critical role in optimizing recovery after radical cystectomy. Various strategies, such as restrictive fluid therapy, goal-directed fluid therapy (GDFT), and warmed fluids, have been studied for their impact on complications and outcomes. However, the optimal approach remains uncertain. **Methods:** We conducted a systematic review in accordance with PRISMA 2020 guidelines. A PubMed search was performed in January 2025. Eligible studies included randomized controlled trials (RCTs) and observational studies published in English that assessed perioperative fluid strategies in radical cystectomy. Two reviewers independently selected studies, with a third resolving discrepancies. Data were extracted on study characteristics, interventions, and outcomes. Risk of bias was assessed using the Cochrane Risk of Bias Tool. Due to heterogeneity, narrative synthesis was used. **Results:** Seventeen studies (eight RCTs, nine observational; total n = 3519) were included. Three publications based on a single RCT (n = 167) showed that restrictive fluid therapy with norepinephrine significantly reduced blood loss ($p < 0.0001$), transfusions ($p = 0.0006$), complications ($p = 0.006$), and hospital stay ($p = 0.02$), with a trend toward fewer 90-day complications ($p = 0.12$). Six studies (four RCTs, two observational) evaluated GDFT. Doppler- and SVV-based GDFT reduced ileus, nausea, wound infections, and blood loss, although findings on renal function and length of stay were mixed. One RCT showed that warmed fluids reduced transfusion needs ($p = 0.028$) and hospital stay ($p = 0.05$). VBFI (Vascular Bed Filling Index)- and aVBFI (adjusted Vascular Bed Filling Index)-guided strategies may lower complications in ileal conduit patients, but evidence remains limited. **Conclusions:** Restrictive fluid therapy with norepinephrine appears to improve outcomes after radical cystectomy. GDFT and warmed fluids show potential benefits, but findings are inconsistent. Further high-quality trials are needed to define the optimal strategy.

Academic Editor: Fumitaka Koga

Received: 1 April 2025

Revised: 13 May 2025

Accepted: 20 May 2025Published: 22 May 2025

Citation: Lipowski, P.; Ostrowski, A.; Adamowicz, J.; Kowalski, F.; Drewa, T.; Juszczak, K. Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review. *Cancers* **2025**, *17*, 1746. https://doi.org/10.3390/cancers17111746

Keywords: bladder cancer; radical cystectomy; fluid therapy

1. Introduction

Radical cystectomy with urinary diversion remains the standard treatment for muscle-invasive bladder cancer. Despite advancements in surgical techniques and perioperative care, the procedure continues to be associated with significant morbidity and complications [1–4].

Multiple factors influence postoperative complications following radical cystectomy. Even inflammatory and hematological parameters appear to have an impact on surgical outcomes [5]. Perioperative fluid management plays a crucial role in optimizing postoperative recovery and minimizing complications, including postoperative ileus [6]. Some reports suggest that the total perioperative fluid administration should not exceed 3 L within the perioperative period [7]. While various perioperative fluid management approaches during radical cystectomy have been described in the literature, the optimal strategy remains undefined.

Restrictive fluid therapy is a key component of the Enhanced Recovery After Surgery (ERAS) protocol, which was originally developed for general surgery and has since been successfully implemented in urological oncology, including radical cystectomy (RC). Incorporating ERAS elements such as fluid restriction, early mobilization, and minimized surgical stress has been shown to reduce hospital length of stay and improve recovery outcomes [8–10]. Meta-analyses further support its benefits in RC, demonstrating lower complication rates and faster return of bowel function [11].

This systematic review aims to evaluate the impact of different perioperative fluid management strategies on surgical outcomes in patients undergoing radical cystectomy. It focuses on key postoperative complications, including ileus, acute kidney injury, and blood transfusion rates. The review follows the PRISMA guidelines to ensure a comprehensive and unbiased synthesis of the available evidence (Supplementary Materials).

2. Materials and Methods

The methodology used in this study adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

A literature search was conducted in January 2025 using the PubMed database with the following search query:

("Cystectomy"[Mesh] OR cystectomy OR "RARC" OR "radical cystectomy") AND ("Perioperative Care"[Mesh] OR "Perioperative Period" OR "ERAS" OR "enhanced recovery after surgery" OR "fluid management" OR "fluid restriction" OR "fluid therapy") AND ("Postoperative Complications"[Mesh] OR complications OR "acute kidney injury" OR "acute kidney failure" OR "hospital stay" OR "bowel function" OR "analgesic use" OR pain OR readmission OR mortality OR "quality of life" OR "QoL" OR "life quality" OR "surgical site infection" OR "SSI" OR ileus OR "blood transfusion" OR "electrolyte imbalance") AND ("Urinary Bladder Neoplasms"[Mesh] OR "bladder cancer" OR "bladder neoplasm"). The retrieved studies were subsequently analyzed.

Randomized controlled trials (RCTs) and observational studies published in English, evaluating the impact of different perioperative fluid therapy strategies during radical cystectomy on postoperative outcomes and complications, were included in the review.

The selection process was conducted by two independent reviewers and verified by a third researcher who resolved any discrepancies. Studies without full-text availability were excluded. The selection process is illustrated in the PRISMA flowchart (Figure 1).

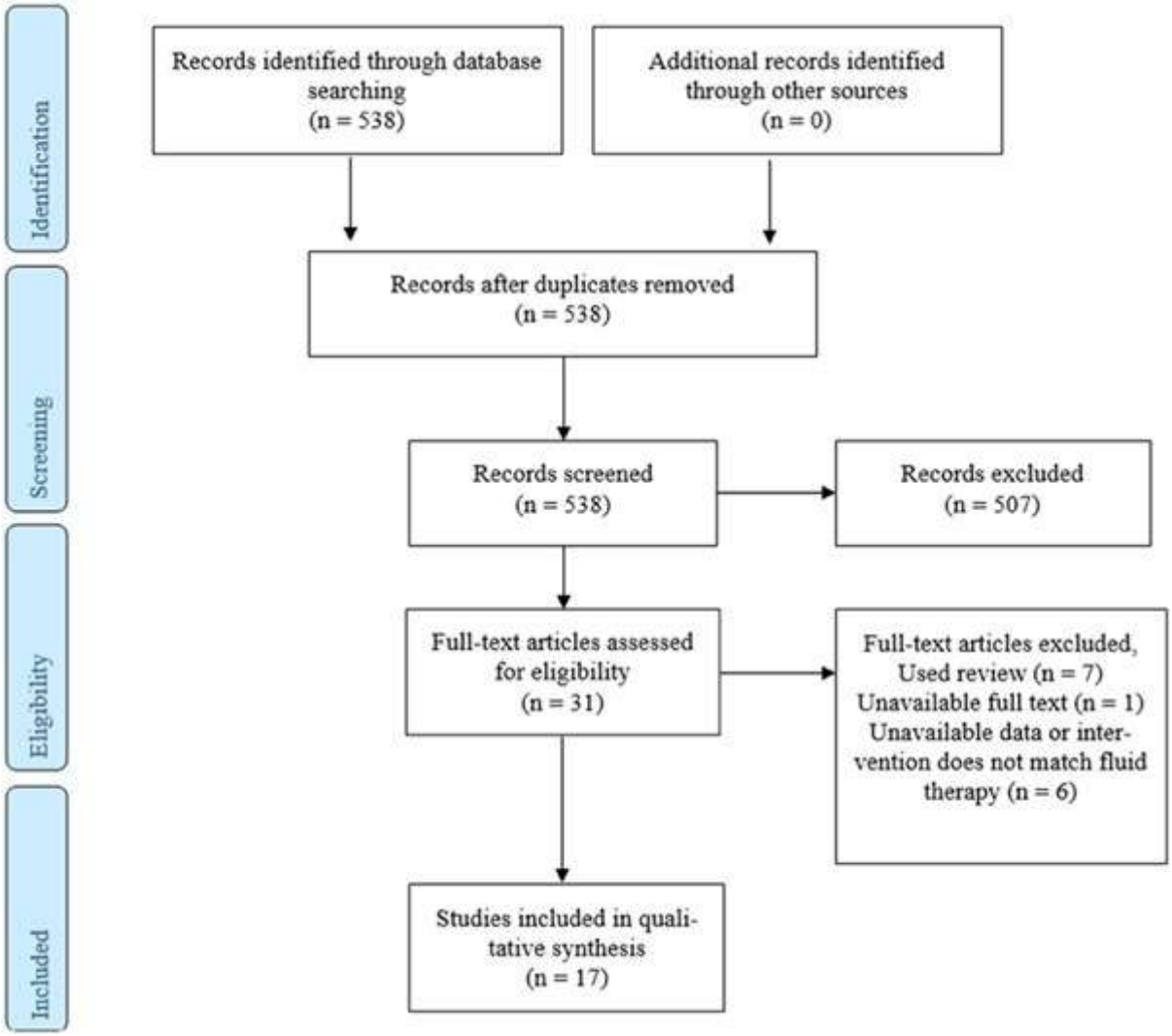


Figure 1. PRISMA flowchart of the study selection process.

Data were extracted regarding authors, year of publication, study type, study population, intervention type, and key outcomes. Study quality was assessed using the Cochrane Risk of Bias Tool (version RoB2). Risk of bias was assessed using the Cochrane Risk of Bias Tool, evaluating domains such as sequence generation, allocation concealment, blinding, completeness of outcome data, and selective reporting. Each domain was classified as hav- ing low, high, or unclear risk of bias based on the criteria outlined in the *Cochrane Handbook*. A narrative synthesis was performed to evaluate significant differences in study designs.

Reporting bias (e.g., publication bias or selective outcome reporting) was not formally assessed due to the narrative nature of the synthesis and the limited number of studies per outcome. Effect measures included mean differences for continuous outcomes (e.g., blood loss and length of stay) and proportions or risk differences for binary outcomes (e.g., complications, transfusions, and AKI). Where available, *p*-values were reported. Other effect measures, such as odds ratios or confidence intervals, were not consistently provided across studies.

The certainty of evidence for selected key outcomes (acute kidney injury, blood loss and transfusions, postoperative ileus, length of hospital stay, and chronic kidney disease) was assessed using an adapted GRADE approach, taking into account risk of bias, consistency, precision, and directness across studies.

This review was not prospectively registered.

3. Results

3.1. Study Selection and Characteristics

A total of 538 articles were identified in the initial search. After screening, 31 articles were subjected to full-text evaluation. Following a rigorous selection process, 17 articles were included in the systematic review.

These 17 studies focused on comparing perioperative fluid therapy strategies in patients undergoing radical cystectomy with lymphadenectomy and urinary diversion for bladder cancer. Among them, 8 studies were randomized controlled trials (RCTs) with a double-blind design, including 3 articles analyzing the same population, with 1 being a follow-up study. The remaining 9 studies were observational, including 6 retrospective studies, 1 prospective study, and 2 studies comparing retrospective and prospective cohorts.

Regarding the surgical approach, 8 studies analyzed patients undergoing open radical cystectomy (ORC), 1 study assessed patients treated with robot-assisted laparoscopic radical cystectomy (RARC), and 1 study included both RARC and ORC. In 5 studies, the surgical approach was not explicitly defined. Additionally, 8 of the included studies incorporated the ERAS (Enhanced Recovery After Surgery) protocol.

The total patient population analyzed across all included studies comprised 3519 patients. The characteristics of the included studies are presented in Table 1. The risk of bias for the included trials was assessed and is summarized in Table 2, where variability in methodological quality is highlighted as a factor potentially influencing the strength of the evidence. Potential reporting bias was not evaluated.

Table 1. Characteristics of included studies.

No.	Author (Year)	Study Design	Participants (Study Group vs. Control Group)	Intervention	Outcomes
1	Luo J. (2020) [12]	RCT	53 vs. 55	Pre-warm fluid infusion use	↓ transfusion, ↓ LOS
2	Kong Y. (2016) [13]	RCT	23 vs. 23	Fluid infusion based on stroke volume variation (SVV) 10–20% vs. <10%	↓ transfusion, ↓ blood loss. ↔ complications, ↔ AKI, ↔ LOS
3	Arslan-Carlon V. (2020) [14]	RCT	142 vs. 141	Goal-directed stroke volume (SV) vs. standard fluid therapy	↑ 30-day complications, ↑ acute kidney injury ↔ ileus, ↔LOS
4	Pillai P. (2011) [15]	RCT	32 vs. 34	Doppler-guided vs. standard fluid therapy	↓ ileus, ↓ nausea, ↓ vomiting. ↓wound infection.
5	Liu T. (2016) [16]	RCT	38 vs. 38	Goal-directed SVV vs. routine fluid therapy	↑ cardiac output index, ↑ MAP, ↑ central venous pressure. Better metabolic index. ↓ nausea, ↓ vomiting, ↓ hypotension.
6	Ghoreifi A. (2021) [17]	Retrospective cohort	119 vs. 192	Goal-directed SVV vs. convectional fluid therapy	↔ kidney function, ↔ LOS, ↔ blood loss, ↔ transfusions, and readmissions.
7	Wei C. (2018) [18]	Retrospective cohort	91 vs. 101	ERAS (less fluids) vs. no ERAS	↓ blood loss, ↓ transfusions, ↓ readmissions, and ↓ complications. ↓ bowel complications.
8	Bazargani T. (2018) [19]	Prospective cohort	180	Total intraoperative fluid volume, type of fluid impact	↔ 30 -, 90-day complications, ↔ in LOS.
9	Dobe T. (2022) [20]	Prospective vs. retrospective control group	29 vs. 50	ERAS (less fluids + vasopressive drugs) vs. no ERAS	↔ blood loss, ↔ transfusions, ↔ ileus, ↔ complications rate. ↓ LOS.
10	Marques M. (2024) [21]	Retrospective cohort	51 vs. 71	No AKI vs. AKI	↑ AKI if restrictive intraoperative vascular filling, female sex, postoperative sepsis, day 1 SOFA score, creatinin D1.

Table 1. *Cont.*

No.	Author (Year)	Study Design	Participants (Study Group vs. Control Group)	Intervention	Outcomes
11	Furrer M. (2018) [22]	Retrospective cohort	100 vs. 812	AKI vs. no AKI	↑ AKI if surgery time >400 min, male, obesity, high blood loss, blood transfusion, more crystalloids.
12	Lipowski P. (2024) [23]	Retrospective cohort	48 vs. 240	Ileal conduit (IC) vs. ureterocutaneostomy (UCS), Vascular Bed Filling Index (VBFI), adjusted Vascular Bed Filling Index (aVBFI)	VBFI, aVBFI: < 8–UCS ↓ complications; = 8–IC = UCS; >8–IC ↑ complications.
13	Wuethrich P. (2013) [24]	RCT	83 vs. 84	Low volume + noradrenaline vs. balanced Ringer's solution	↓ hospital complications, ↓ gastrointestinal, ↓ cardiac, ↓ 90 days complications. ↓ LOS.
14	Wuethrich P. (2013) [25]	RCT	83 vs. 84	Low volume + noradrenaline vs. balanced Ringer's solution	↓ blood loss, ↓ transfusions.
15	Mei Wen Wu F. (2013) [26]	RCT	83 vs. 84	Low volume + noradrenaline vs. balanced Ringer's solution	↔ in renal function 7 days, 3, 6, and 12 months after surgery.
16	Jubber I. (2019) [27]	Retrospective cohort	430	High-volume anesthetist vs. low-volume anesthetist	↓ LOS, ↓ blood loss, ↓ transfusion rate.
17	Patel S. (2018) [28]	Retrospective cohort	116 vs. 143	Multidisciplinary ERAS (goal-directed fluid therapy) vs. surgical ERAS	↓ intraoperative transfusions, ↓ nausea. ↔ in bowel function, ↔ LOS, ↔ 30 and 90 days complications, ↔ readmissions.

Abbreviations: LOS—length of stay; AKI—acute kidney injury; VBFI—Vascular Bed Filling Index; aVBFI—adjusted Vascular Bed Filling Index; ERAS—Enhanced Recovery After Surgery; ↓—significant reduction (favorable effect); ↑—significant increase (unfavorable effect); ↔—no significant difference.

Table 2. Cochrane Risk of Bias (risk (high/low/unclear).

No.	Author (Year)	Random Sequence Generation	Allocation Concealment	Blinding of Participants and Personnel	Blinding of Outcome Assessment	Incomplete Data	Selective Reporting	Main Limitations/Quality Considerations
1	Luo J. (2020) [12]	Unclear	Unclear	Unclear	Unclear	Low	Low	Randomization and blinding procedures poorly described, potential risk of bias.
2	Kong Y. (2016) [13]	Low	Low	Low	Low	Low	Low	Good methodology but small sample size (risk of imprecise estimates).
3	Arslan-Carlon V. (2020) [14]	Low	Low	Low	Low	Low	Low	Good methodology, large sample size, low risk of bias.
4	Pillai P. (2011) [15]	High	Unclear	Unclear	Unclear	Low	Low	Small sample size, unclear, randomization and blinding procedures, high risk of bias.
5	Liu T. (2016) [16]	High	Unclear	Unclear	Unclear	Low	Low	Small sample size, unclear randomization details, moderate risk of bias.
6	Ghoreifi A. (2021) [17]	High	High	High	High	Low	Low	Retrospective observational design, possible selection and confounding biases.
7	Wei C. (2018) [18]	High	High	High	High	Low	Unclear	Retrospective, observational study design, risk of selection and confounding biases.
8	Bazargani T. (2018) [19]	High	High	High	High	Low	Low	Observational design without clear control group, potential confounding bias.
9	Dobe T. (2022) [20]	High	High	High	High	Low	Low	Small sample size, mixed prospective-retrospective groups, risk of confounding and selection bias

Table 2. *Cont.*

No.	Author (Year)	Random Sequence Generation	Allocation Concealment	Blinding of Participants and Personnel	Blinding of Outcome Assessment	Incomplete Data	Selective Reporting	Main Limitations/Quality Considerations
10	Marques M. (2024) [21]	High	High	High	High	Low	Low	Retrospective design, limited to AKI risk factors, potential confounding bias.
11	Furrer M. (2018) [22]	High	High	High	High	Low	Low	Retrospective design, large population but significant confounding risks.
12	Lipowski P. (2024) [23]	High	High	High	High	Low	Low	Single-center, retrospective, exploratory and hypothesis generating.
13	Wuethrich P. (2013) [24]	Low	Low	Low	Low	Low	Low	Strong methodology, single population, limited external validity.
14	Wuethrich P. (2013) [25]	Low	Low	Low	Low	Low	Low	Strong methodology, single population, limited external validity
15	Mei Wen Wu F. (2013) [26]	Low	Low	Low	Low	Low	Low	Strong methodology, single population, limited external validity
16	Jubber I. (2019) [27]	High	High	High	High	Unclear	Low	Retrospective design, high-volume anesthetist group limited to few providers, risk of bias
17	Patel S. (2018) [28]	High	High	High	High	Low	Low	Retrospective design, historical control group, significant selection and confounding biases.

3.2. Restrictive Fluid Therapy with Norepinephrine Use

The use of norepinephrine infusion combined with restrictive fluid therapy is described in three publications based on a single randomized clinical trial [20–22].

A total of 83 patients were included in the study group, and 84 in the control group. The results indicate that the application of restrictive fluid therapy combined with norepinephrine infusion significantly reduces blood loss (800 mL vs. 1200 mL; $p < 0.0001$) and decreases the need for blood product transfusion (33% vs. 60%; $p = 0.0006$). This approach also lowers the risk of complications during hospitalization (52% vs. 73%; $p = 0.006$), including gastrointestinal complications (6% vs. 31%; $p < 0.0001$) and cardiovascular complications (20% vs. 48% $p = 0.0003$). Moreover, it shortens the length of hospital stay (15 days vs. 17 days; $p = 0.02$) and reduces mortality within 90 days postoperatively (0% vs. 4.8%; $p = 0.12$).

3.3. Goal-Directed Fluid Therapy (GDFT)

Goal-directed fluid therapy refers to individualized fluid administration guided by dynamic hemodynamic parameters to optimize tissue perfusion and avoid fluid overload. The use of GDFT is described in six studies, including four randomized trials [9–11,13] and two observational studies [17,28]. The total number of patients in the study groups was 470, while 551 patients were assigned to the control groups. Both observational studies incorporated the ERAS protocol.

Ghoreifi et al. [17] found no significant differences between GDFT and conventional fluid therapy in terms of blood loss (567 mL vs. 580 mL; $p = 0.6$), eGFR trend ($p = 0.85$), length of stay (4 days in both groups; $p = 0.85$), 90-day high-grade complication rate (17.6% vs. 17.2%; $p = 0.5$), or 90-day readmissions (28.6% vs. 29.7%; $p = 0.9$). Patel et al. [28] reported a lower intraoperative blood transfusion rate (0.58 vs. 0.97; $p \leq 0.001$) and a lower incidence of nausea (3.1% vs. 8.1%; $p < 0.05$) in the GDFT group. However, no significant differences were observed in length of stay (LOS) (6 days in both groups; $p = 0.89$), peak pain levels (4.4 vs. 4.4; $p = 0.89$), or 30- and 90-day readmissions ($p = 0.34$ and $p = 0.14$, respectively). The authors noted no differences in time to first flatus or 30- and 90-day complication rates, but p-values were not provided for these variables.

Randomized trials assessing GDFT using Doppler ultrasound demonstrated a lower risk of ileus (22% vs. 53%; $p < 0.001$), nausea (9% vs. 32% $p < 0.01$), or time to flatus (3.55 days vs. 5.36 days; $p < 0.01$ [15]. Wound infection rates were reduced in the study group (1 vs. 8; $p < 0.01$). Liu et al. [16] demonstrated a lower risk of nausea, vomiting, and hypotension (all $p < 0.05$). Patients in the intervention groups experienced a faster return of bowel function (2.1 days vs. 3.0 days; $p < 0.05$); however, the length of hospital stay was shorter in the control group (11.5 days vs. 13.7 days; $p < 0.05$).

GDFT based on stroke volume variation (SVV) was associated with reduced blood loss (734.3 mL vs. 1096.5 mL; $p = 0.019$) and a lower transfusion rate (0.5 units vs. 1.9 units; $p = 0.005$). However, this did not significantly affect gastrointestinal function ($p = 0.326$, $p = 0.4$) or length of hospital stay ($p = 0.23$, $p = 0.9$) [13].

The data regarding acute kidney injury (AKI) are conflicting. A study with a larger sample size reported a higher risk of AKI in the GDFT group (56% vs. 40%; $p = 0.005$) [14].

Given the variation in study designs, populations, interventions, and outcome measures, a quantitative synthesis was deemed inappropriate.

3.4. Warming Fluid Transfusion

A randomized clinical trial by Luo et al. indicates that perioperative fluid therapy using warmed fluids at 38–42 °C in patients undergoing robot-assisted radical cystectomy (RARC) reduces fluid transfusions (1903 mL vs. 2153 mL; $p = 0.028$) and shortens the length

of hospital stay (16 days vs. 20 days; $p = 0.05$). However, it does not affect blood loss, the need for reoperation, or bowel function [12].

3.5. Vascular Bed Filling Index

In another study of ours, we proposed the use of the Vascular Bed Filling Index (VBFI) and the adjusted Vascular Bed Filling Index (aVBFI) to determine the optimal volume of perioperatively administered fluids [23]. These indices are based on blood loss, the volume of perioperatively administered fluids, and the duration of the surgical procedure. The results suggest that fluid therapy guided by these indices may reduce the severity of complications after radical cystectomy, particularly in patients undergoing urinary diversion using an ileal conduit (VBFI = between 0 and 8; $p = 0.011$ for VBFI; $p = 0.005$ for aVBFI). Although the VBFI/aVBFI-guided approach showed a reduction in complications in patients undergoing ileal conduit diversion, it should be considered exploratory and hypothesis-generating, as it is based on a single retrospective study from the authors' institution.

3.6. Anesthetist Impact

A retrospective study evaluated the impact of anesthesiologist experience on the outcomes of radical cystectomy. The study indicates that greater anesthesiologist experience (>10 cases) is associated with reduced blood loss (600 mL vs. 800 mL, $p < 0.001$) and a lower transfusion rate (7.2% vs. 22%, $p = 0.001$). However, it does not affect mortality or the need for rehospitalization [27].

3.7. Impact on Specific Complications

3.7.1. Acute Kidney Injury

Based on assessments of four studies (included two randomized trials and two retrospective observational studies), the relationship between perioperative fluid therapy and acute kidney injury (AKI) was analyzed. Both randomized trials compared the effects of goal-directed fluid therapy (GDFT) with control groups.

In the randomized studies, a total of 165 patients were included in the intervention groups, and 164 patients in the control groups. In both studies, the risk of AKI was higher in the intervention group. In a study by Kong et al. [13], 8 patients (34%) in the GDFT group and 6 patients (26%) in the control group developed AKI ($p = 0.522$). However, these numbers did not reach statistical significance, likely due to the small sample size. In contrast, Arslan-Carlon et al. [14] analyzed a larger cohort, where the risk of AKI was significantly higher in the restrictive fluid therapy group (56% vs. 40%, $p = 0.005$).

The results of observational studies are inconsistent. One observational study also indicates a higher risk of AKI in patients who received <5 mL/kg/h of perioperative fluids ($p = 0.043$, Citation 15). Conversely, Furrer et al. suggests that the administration of >2527 mL of crystalloids intraoperatively is associated with an increased risk of AKI ($p = 0.3$) [22].

3.7.2. Blood Loss and Transfusions

The results of four randomized clinical trials assessed perioperative blood loss and transfusion rates. Two studies investigated goal-directed fluid therapy (GDFT), one examined warming fluid transfusion, and one evaluated norepinephrine-assisted restrictive fluid therapy.

Restrictive fluid therapy with norepinephrine significantly reduced intraoperative transfusion rates (8% vs. 31%; $p < 0.001$) and postoperative transfusion requirements (28% vs. 48%, $p = 0.0006$) [25].

The findings regarding GDFT were inconsistent. Kong et al. [15] demonstrated that stroke volume variation (SVV) monitoring for fluid optimization significantly reduced

blood loss (734 mL vs. 1096 mL; $p < 0.001$) and the number of transfusions (0.5–0.8 units vs. 1.9–2.2 units; $p = 0.005$) [13]. Conversely, Pillai et al. [15] found that Doppler ultrasound-based fluid therapy had no significant impact on blood loss ($p = 0.6$) or red blood cell transfusion requirements ($p = 0.82$). However, both of these studies had small sample sizes, with 23 vs. 23 and 32 vs. 34 patients in the study and control groups, respectively.

Additionally, warming fluid transfusion at 43 °C during cystectomy did not significantly affect blood loss ($p = 0.19$) [12].

3.7.3. Postoperative Ileus

Postoperative ileus is a significant concern in patients undergoing radical cystectomy. This issue was addressed in four clinical studies, with a total of 334 patients in the intervention groups and 337 patients in the control groups.

The use of low-dose norepinephrine was associated with a significant reduction in the risk of ileus (6% vs. 37%; $p = 0.007$) and gastrointestinal complications (6% vs. 31%; $p < 0.0001$) [24].

The remaining findings regarding various GDFT strategies were inconsistent. Most data indicate no significant effect of GDFT on the incidence of postoperative ileus ($p = 0.4–(14)$; $p = 0.3–(13)$).

Only Pillai et al. [15] demonstrated a positive impact of GDFT on postoperative ileus ($p < 0.001$), bowel motility ($p = 0.01$), and time to first bowel movement ($p = 0.02$); however, this study had a small sample size.

3.8. Length of Stay

The findings regarding hospital length of stay (LOS) are as follows: Restrictive fluid therapy combined with norepinephrine infusion significantly reduced hospital stay (15 days vs. 17 days; $p = 0.01$) [24]. In contrast, GDFT did not impact LOS (7 days vs. 7 days; $p = 0.9$) [14], while warming fluid transfusion at 38–42 °C was associated with a shorter hospital stay (16 days vs. 20 days; $p = 0.05$) [12].

All of the above findings are derived from randomized clinical trials; however, it is noteworthy that significant differences were observed only in studies where the average hospital stay exceeded several days.

Additionally, an observational study using SVV-based GDFT found no difference in LOS between groups (4 days vs. 4 days; $p = 0.85$) [17].

3.9. Chronic Kidney Disease

A randomized clinical trial comparing conventional fluid therapy with restrictive fluid therapy combined with norepinephrine infusion found no significant differences in kidney function between groups after 7 days ($p = 0.37$) and at 3, 6, and 12 months after discharge ($p = 0.49$; $p = 0.197$; and $p = 0.78$, respectively) [26].

However, the study identified independent risk factors for kidney function deterioration, including diabetes ($p = 0.002$), preoperative eGFR ($p = 0.007$), and age ($p = 0.038$).

3.10. Certainty of Evidence (GRADE Assessment)

The overall certainty of evidence for outcomes was low to moderate. Certainty ratings were based on study design, consistency of results, precision of estimates, and risk of bias, following the GRADE framework. According to the GRADE assessment, the evidence was rated as low for acute kidney injury, postoperative ileus, and length of stay due to inconsistency and imprecision across studies. Moderate certainty was assigned to outcomes such as blood loss and transfusions and chronic kidney disease based on consistent findings and lower risk of bias. Detailed ratings are presented in Table 3.

Table 3. Grade summary table.

Outcome	No. of Studies	Consistency	Precision	Risk of Bias	Certainty (GRADE)
Acute Kidney Injury (AKI)	4 (2 RCTs, 2 obs.)	Inconsistent	Imprecise (small N, some $p > 0.05$)	Moderate to high (obs. studies, limited blinding)	Low
Blood Loss and Transfusions	4 RCTs	Partially consistent	Moderate (some large effects)	Low to moderate (RCTs well reported)	Moderate
Postoperative Ileus	4 studies (mixed)	Mixed results	Low (small N in key studies)	High in some studies	Low
Length of Hospital Stay	4 RCTs + obs.	Inconsistent	Low (heterogeneity of LOS reporting)	Moderate	Low
Chronic Kidney Disease	1 RCT	Consistent	Moderate	Low	Moderate

Reporting bias was not formally evaluated, and no results related to publication bias are available.

4. Discussion

This systematic review assessed the impact of various perioperative fluid therapy strategies in patients undergoing radical cystectomy with lymphadenectomy and urinary diversion due to bladder cancer. The analyzed studies exhibit significant heterogeneity, and some contain methodological limitations, making direct comparisons between studies challenging. It is important to note that radical cystectomy and its postoperative complications vary significantly depending on the type of urinary diversion used [29]. This factor further complicates direct comparisons between studies.

The results of the current systematic review suggest that the most optimal approach involves restrictive fluid therapy combined with low-dose norepinephrine infusion or goal-directed fluid therapy (GDFT) using stroke volume variation (SVV) for fluid administration. The administration of pre-warmed fluids also appears to be a noteworthy strategy.

However, it is essential to consider that the Enhanced Recovery After Surgery (ERAS) protocol is actively implemented during radical cystectomy, contributing to reduced postoperative complications and faster recovery [26–30]. Since all components of the ERAS protocol work synergistically, evaluating fluid therapy in isolation from the protocol may be controversial. In this review, the ERAS protocol was applied in eight studies, but the methodologies of these studies do not allow for direct comparisons.

Restrictive fluid therapy with norepinephrine during radical cystectomy appears to be a promising strategy; however, ERAS was not implemented in these studies [20–22]. This approach has also been investigated in other surgical fields, including liver surgery [31], thoracic surgery [32], and head and neck oncological surgery [33], showing favorable outcomes.

The GDFT strategy, based on stroke volume variation or transesophageal Doppler monitoring, also appears to be a beneficial approach. However, randomized controlled trials evaluating these techniques included small sample sizes and did not involve concurrent ERAS protocol implementation [9,11,12].

Fluid therapy with pre-warmed fluids at approximately 41 °C may also be a valuable strategy. Although the total population of studies investigating this method during radical cystectomy is relatively small, this approach has demonstrated efficacy in other surgical procedures, including in elderly patients [33–36].

Differences in surgical approach (robotic vs. open) and urinary diversion technique (intracorporeal vs. extracorporeal) may influence key perioperative outcomes such as. Bleeding , postoperative ileus, and length of stay, and should therefore be taken into account when evaluating the effects of fluid management strategies [37,38].

The studies included in this review also differ in terms of surgical technique. It is important to emphasize that a significant proportion of radical cystectomies are now performed using laparoscopic or robot-assisted techniques. Robot-assisted surgery is associated with a longer operative time but a lower need for blood transfusion [37,38]. Based on these findings, the optimal fluid therapy strategy should also be considered in conjunction with the surgical approach.

The use of the Vascular Bed Filling Index and adjusted Vascular Bed Filling Index is based on a single retrospective study and requires further research to draw definitive conclusions.

This review was not prospectively registered, and only one database (PubMed) was searched, which may have led to selection bias. Only English-language publications were included, potentially omitting relevant evidence. Although study selection was conducted by two independent reviewers, data extraction and bias assessment were not independently duplicated. Reporting bias was not assessed, and certainty of evidence was evaluated only for selected outcomes. The included studies exhibited substantial heterogeneity in terms of design, population, surgical approach, and outcome reporting. A significant proportion of studies were observational and retrospective, with potential confounding and variable implementation of ERAS protocols. Additionally, the lack of standardized definitions for key outcomes, such as postoperative ileus or complications, limits comparability across studies. The presence of high or unclear risk of bias in multiple studies highlights the need for cautious interpretation of the findings and underlines the importance of high-quality randomized trials in this field.

Based on current evidence, restrictive fluid therapy with norepinephrine may reduce perioperative complications and blood loss, and could be considered as part of perioperative strategies in radical cystectomy, especially where ERAS protocols are not fully implemented. GDFT shows potential for reducing gastrointestinal complications and improving recovery, although findings on renal outcomes are inconsistent and warrant caution.

Future research should focus on direct comparisons of fluid therapy strategies in conjunction with the ERAS protocol and modern surgical techniques, with particular emphasis on the type of urinary diversion used.

5. Conclusions

Restrictive therapy with norepinephrine reduces blood loss and complications, while goal-directed fluid therapy improves hemodynamics but has mixed effects on complications and hospital stay. Warming fluids lower transfusions, and Vascular Bed Filling Index–based management may reduce complications, though evidence is limited. Further research is needed to determine the optimal approach.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/cancers17111746/s1, PRISMA 2020 Checklist.

Author Contributions: Conceptualization, P.L. and A.O.; methodology, A.O. and P.L.; software, F.K.; validation, J.A., P.L. and T.D.; formal analysis, P.L. and K.J.; investigation, P.L.; resources, P.L.; data curation, P.L. and F.K; writing—original draft preparation, P.L.; writing—review and editing, A.O., K.J. and J.A.; visualization, P.L. and A.O.; supervision, K.J. and T.D.; project administration, K.J.; funding acquisition, K.J. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data sharing is not applicable to this article as no new data were created or analyzed in this study.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Maibom, S.L.; Joensen, U.N.; Poulsen, A.M.; Kehlet, H.; Brasso, K.; Røder, M.A. Short-term morbidity and mortality following radical cystectomy: A systematic review. *BMJ Open* **2021**, *11*, e043266. [CrossRef] [PubMed]
2. Duquesne, I.; Benamran, D.; Masson-Lecomte, A.; De La Taille, A.; Peyromaure, M.; Rouprêt, M.; Delongchamps, N.B. Intraoperative complication of radical cystectomy for muscle-invasive bladder cancer: Does the surgical approach matter? A retrospective multicenter study using the EAUiaiC classification. *World J. Urol.* **2023**, *41*, 1061–1067. [CrossRef] [PubMed]
3. van Ginkel, N.; Meijer, D.; Boormans, J.L.; Mertens, L.S.; van Beek, S.C.; Vis, A.N. The Dutch Cystectomy Snapshot Research Group Predictors of Major Complications and the Association with Oncological Outcomes After Radical Cystectomy for Bladder Cancer: A Nationwide Registry Study. *Med. Res. Arch.* **2023**, *11*. [CrossRef]
4. Katsimperis, S.; Tzelves, L.; Tandogdu, Z.; Ta, A.; Geraghty, R.; Bellos, T.; Manolitsis, I.; Pyrgidis, N.; Schulz, G.B.; Sridhar, A.; et al. Complications After Radical Cystectomy: A Systematic Review and Meta-analysis of Randomized Controlled Trials with a Meta-regression Analysis. *Eur. Urol. Focus* **2023**, *9*, 920–929. [CrossRef]
5. S´lusarczyk, A.; Pustuła, P.; Garbas, K.; Zapała, Ł.; Radziszewski, P. Mean platelet volume to lymphocyte ratio as an inflammatory marker associated with high-grade recurrence and progression of non-muscle-invasive bladder cancer treated with Bacillus Calmette-Guérin. *Cent. Eur. J. Urol.* **2024**, *77*, 599–611.
6. Gómez-Izquierdo, J.C.; Feldman, L.S.; Carli, F.; Baldini, G. Meta-analysis of the effect of goal-directed therapy on bowel function after abdominal surgery. *Br. J. Surg.* **2015**, *102*, 577–589. [CrossRef]
7. Schwenk, W.; Flemming, S.; Girona-Johannkämper, M.; Wendt, W.; Darwich, I.; Strey, C. Structured implementation of fast-track pathways to enhance recovery after elective colorectal resection: First results from five German hospitals. *Chirurgie* **2024**, *95*, 148–156. [CrossRef]
8. Daneshmand, S.; Ahmadi, H.; Schuckman, A.K.; Mitra, A.P.; Cai, J.; Miranda, G.; Djaladat, H. Enhanced recovery protocol after radical cystectomy for bladder cancer. *J. Urol.* **2014**, *192*, 50–56. [CrossRef]
9. Frees, S.K.; Aning, J.; Black, P.; Struss, W.; Bell, R.; Chavez-Munoz, C.; Gleave, M.; So, A.I. A prospective randomized pilot study evaluating an ERAS protocol versus a standard protocol for patients treated with radical cystectomy and urinary diversion for bladder cancer. *World J. Urol.* **2018**, *36*, 215–220. [CrossRef]
10. Persson, B.; Carringer, M.; Andrén, O.; Andersson, S.-O.; Carlsson, J.; Ljungqvist, O. Initial experiences with the enhanced recovery after surgery (ERAS®) protocol in open radical cystectomy. *Scand. J. Urol.* **2015**, *49*, 302–307. [CrossRef]
11. Tyson, M.D.; Chang, S.S. Enhanced Recovery Pathways Versus Standard Care After Cystectomy: A Meta-analysis of the Effect on Perioperative Outcomes. *Eur. Urol.* **2016**, *70*, 995–1003. [CrossRef] [PubMed]
12. Luo, J.; Zhou, L.; Lin, S.; Yan, W.; Huang, L.; Liang, S. Beneficial effect of fluid warming in elderly patients with bladder cancer undergoing Da Vinci robotic-assisted laparoscopic radical cystectomy. *Clinics* **2020**, *75*, e1639. [CrossRef]
13. Kong, Y.-G.; Kim, J.Y.; Yu, J.; Lim, J.; Hwang, J.-H.; Kim, Y.-K. Efficacy and safety of stroke volume variation-guided fluid therapy for reducing blood loss and transfusion requirements during radical cystectomy: A randomized clinical trial. *Medicine* **2016**, *95*, e3685. [CrossRef]
14. Arslan-Carlon, V.; Tan, K.S.; Dalbagni, G.; Pedoto, A.C.; Herr, H.W.; Bochner, B.H.; Cha, E.K.; Donahue, T.F.; Fischer, M.; Donat, S.M. Goal-directed versus standard fluid therapy to decrease ileus after open radical cystectomy: A prospective randomized controlled trial. *Anesthesiology* **2020**, *133*, 293–303. [CrossRef]
15. Pillai, P.; McEleavy, I.; Gaughan, M.; Snowden, C.; Nesbitt, I.; Durkan, G.; Johnson, M.; Cosgrove, J.; Thorpe, A. A double-blind randomized controlled clinical trial to assess the effect of doppler optimized intraoperative fluid management on outcome following radical cystectomy. *J. Urol.* **2011**, *186*, 2201–2206. [CrossRef]
16. Liu, T.-J.; Zhang, J.-C.; Gao, X.-Z.; Tan, Z.-B.; Wang, J.-J.; Zhang, P.-P.; Cheng, A.-B.; Zhang, S.-B. Clinical research of goal-directed fluid therapy in elderly patients with radical resection of bladder cancer. *J. Cancer Res. Ther.* **2018**, *14*, S173–S179. [CrossRef]
17. Ghoreifi, A.; Basin, M.F.; Ghodoussipour, S.; Bazargani, S.T.; Amini, E.; Aslzare, M.; Cai, J.; Miranda, G.; Sugeir, S.; Bhanvadia, S.; et al. Perioperative outcomes of goal-directed versus conventional fluid therapy in radical cystectomy with enhanced recovery protocol. *Int. Urol. Nephrol.* **2021**, *53*, 1827–1833. [CrossRef]

18. Wei, C.; Wan, F.; Zhao, H.; Ma, J.; Gao, Z.; Lin, C. Application of enhanced recovery after surgery in patients undergoing radical cystectomy. *J. Int. Med. Res.* **2018**, *46*, 5011–5018. [CrossRef]
19. Bazargani, S.T.; Ghodoussipour, S.; Tse, B.; Miranda, G.; Cai, J.; Schuckman, A.; Daneshmand, S.; Djaladat, H. The association between intraoperative fluid intake and postoperative complications in patients undergoing radical cystectomy with an enhanced recovery protocol. *World J. Urol.* **2018**, *36*, 401–407. [CrossRef]
20. Dobé, T.-R.; Belhadj, Y.; Michel, C.; Djouadou, M.; Bouchardi, A.; Liron, C.; Bento, C.; Aregui, A.; Meria, P.; Thevenot, A.; et al. Perioperative results of radical cystectomy after neoadjuvant chemotherapy according to the implementation of ERAS pathway. *Progres Urol.* **2022**, *32*, 401–409. [CrossRef]
21. Marques, M.; Tezier, M.; Tourret, M.; Cazenave, L.; Brun, C.; Duong, L.N.; Cambon, S.; Pouliquen, C.; Ettori, F.; Sannini, A.; et al. Risk factors for postoperative acute kidney injury after radical cystectomy for bladder cancer in the era of ERAS protocols: A retrospective observational study. *PLoS ONE* **2024**, *19*, e0309549. [CrossRef] [PubMed]
22. Furrer, M.A.; Schneider, M.P.; Löffel, L.M.; Burkhard, F.C.; Wuethrich, P.Y. Impact of intra-operative fluid and noradrenaline administration on early postoperative renal function after cystectomy and urinary diversion. *Eur. J. Anaesthesiol.* **2018**, *35*, 641–649. [CrossRef] [PubMed]
23. Lipowski, P.; Ostrowski, A.; Adamowicz, J.; Jasiewicz, P.; Kowalski, F.; Drewa, T.; Juszczak, K. Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy? *Cancers* **2024**, *17*, 102. [CrossRef]
24. Wüthrich, P.Y.; Burkhard, F.C.; Thalmann, G.; Stueber, F.; Studer, U. Restrictive Deferred Hydration Combined with Preemptive Norepinephrine Infusion During Radical Cystectomy Reduces Postoperative Complications and Hospitalization Time: A Randomized Clinical Trial. *Anesthesiology* **2014**, *120*, 365–377. [CrossRef]
25. Wuethrich, P.Y.; Studer, U.E.; Thalmann, G.N.; Burkhard, F.C. intraoperative continuous norepinephrine infusion combined with restrictive deferred hydration significantly reduces the need for blood transfusion in patients undergoing open radical cystectomy: Results of a prospective randomised trial. *Eur. Urol.* **2014**, *66*, 352–360. [CrossRef]
26. Wu, F.M.W.; Burkhard, F.; Turri, F.; Furrer, M.; Loeffel, L.; Thalmann, G.; Wuethrich, P. Renal outcome after radical cystectomy and urinary diversion performed with restrictive hydration and vasopressor administration in the frame of an enhanced recovery program: A follow-up study of a randomized clinical trial. *Urol. Oncol. Semin. Orig. Investig.* **2017**, *35*, 602.e11–602.e17. [CrossRef]
27. Jubber, I.; Pang, K.H.; Groves, R.; Reed, O.; Noon, A.P.; Catto, J.W.; Cumberbatch, M.G. Impact of Anaesthetist Volume on Radical Cystectomy Outcomes. *Eur. Urol. Focus* **2021**, *7*, 117–123. [CrossRef]
28. Patel, S.Y.; Getting, R.E.G.; Alford, B.; Hussein, K.; Schaible, B.J.; Boulware, D.; Lee, J.K.; Gilbert, S.M.; Powsang, J.M.; Sexton, W.J.; et al. Improved Outcomes of Enhanced Recovery After Surgery (ERAS) Protocol for Radical Cystectomy with Addition of a Multidisciplinary Care Process in a US Comprehensive Cancer Care Center. *World J. Surg.* **2018**, *42*, 2701–2707. [CrossRef]
29. Tappero, S.; Dell'Oglio, P.; Cerruto, M.A.; Salas, R.S.; Rueda, O.B.; Simone, G.; Hendricksen, K.; Soria, F.; Umari, P.; Antonelli, A.; et al. Ileal Conduit Versus Orthotopic Neobladder Urinary Diversion in Robot-assisted Radical Cystectomy: Results from a Multi-institutional Series. *Eur. Urol. Open Sci.* **2023**, *50*, 47–56. [CrossRef]
30. Crettenand, F.; M'baya, O.; Grilo, N.; Valerio, M.; Dartiguenave, F.B.; Cerantola, Y.; Roth, B.; Rouvé, J.-D.; Blanc, C.; Lucca, I. ERAS® protocol improves survival after radical cystectomy: A single-center cohort study. *Medicine* **2022**, *101*, e30258. [CrossRef]
31. Coeckelenbergh, S.; Soucy-Proulx, M.; Van der Linden, P.; Roullet, S.; Moussa, M.; Kato, H.; Toubal, L.; Naili, S.; Rinehart, J.; Grogan, T.; et al. Restrictive versus Decision Support Guided Fluid Therapy during Major Hepatic Resection Surgery: A Randomized Controlled Trial. *Anesthesiology* **2024**, *141*, 881–890. [CrossRef] [PubMed]
32. Gao, Y.; Ji, D.; Fang, Q.; Li, Y.; Wang, K.; Liu, J.; Wang, L.; Gu, E.; Zhang, L.; Chen, L. Effect of low-dose norepinephrine combined with goal-directed fluid therapy on postoperative pulmonary complications in lung surgery: A prospective randomized controlled trial. *J. Clin. Anesthesia* **2024**, *99*, 111645. [CrossRef] [PubMed]
33. Al Saied, G.; Almutairi, H.M.; Alharbi, Y.; Almohanna, M.; Almutairi, A. Comparison Between the Impact of Vasopressors and Goal-Directed Fluid Therapy on the Management of Free Flap Reconstruction of Head and Neck and Monitoring in ICU. *Cureus* **2020**, *12*, e12108. [CrossRef]
34. Simegn, G.D.; Bayable, S.D.; Fetene, M.B. Prevention and management of perioperative hypothermia in adult elective surgical patients: A systematic review. *Ann. Med. Surg.* **2021**, *72*, 103059. [CrossRef]
35. Roshan, M.B.A.; Jafarpoor, H.; Shamsalinia, A.; Fotokian, Z.; Hamidi, S.H. Effects of a forced-air warming system and warmed intravenous fluids on hemodynamic parameters, shivering, and time to awakening in elderly patients undergoing open cardiac surgery. *Ann. Card. Anaesth.* **2023**, *26*, 386–392. [CrossRef]
36. Camus, Y.; Delva, E.; Cohen, S.; Lienhart, A. The effects of warming intravenous fluids on intraoperative hypothermia and postoperative shivering during prolonged abdominal surgery. *Acta Anaesthesiol. Scand.* **1996**, *40*, 779–782. [CrossRef]

37. Cella, L.; Basile, G.; Moretto, S.; Paciotti, M.; Hurle, R.; Lughezzani, G.; Avolio, P.P.; Piccolini, A.; Mancon, S.; Lazzeri, M.; et al. Robotic assisted vs open radical cystectomy: An updated systematic review and meta-analysis. *J. Robot. Surg.* **2024**, *18*, 277. [CrossRef]
38. Mastroianni, R.; Tuderti, G.; Ferriero, M.; Anceschi, U.; Bove, A.M.; Brassetti, A.; D'Annunzio, S.; Misuraca, L.; Torregiani, G.; Covotta, M.; et al. Robot-assisted Radical Cystectomy with Totally Intracorporeal Urinary Diversion Versus Open Radical Cystectomy: 3-Year Outcomes from a Randomised Controlled Trial. *Eur. Urol.* **2024**, *85*, 422–430. [CrossRef]

7.2 Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy?

cancers MDPI

Article

Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy?

Paweł Lipowski [1,*], Adam Ostrowski [1], Jan Adamowicz [1,2], Przemysław Jasiewicz [3], Filip Kowalski [1], Tomasz Drewa [1] and Kajetan Juszczak [1,*]

[1] Department of Urology and Andrology, Collegium Medicum, Nicolaus Copernicus University, M. Curie Skłodowskiej 9, 85-094 Bydgoszcz, Poland; adostro@gmail.com (A.O.); adamowicz.jz@gmail.com (J.A.); urologpolska@gmail.com (F.K.); t.drewa@wp.pl (T.D.)
[2] Department of Regenerative Medicine, Collegium Medicum, Nicolaus Copernicus University, M. Curie Skłodowskiej 9, 85-094 Bydgoszcz, Poland
[3] Department of Anesthesiology and Intensive Care, Collegium Medicum, Nicolaus Copernicus University, 85-094 Bydgoszcz, Poland; pjasiewicz@cm.umk.pl
* Correspondence: pavelipovsky@gmail.com (P.L.); kaj.juszczak@gmail.com (K.J.); Tel.: +48-52-585-60-80 (P.L. & K.J.)

check for updates

Received: 1 December 2024
Revised: 25 December 2024
Accepted: 29 December 2024
Published: 31 December 2024

Citation: Lipowski, P.; Ostrowski, A.; Adamowicz, J.; Jasiewicz, P.; Kowalski, F.; Drewa, T.; Juszczak, K. Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy? *Cancers* **2025**, *17*, 102. https://doi.org/10.3390/cancers17010102

Simple Summary: Intravenous fluid management plays a key role in perioperative care, particularly in patients undergoing radical cystectomy (RC) within enhanced recovery after surgery (ERAS) protocols. This study analyzed 288 patients who underwent laparoscopic RC with urinary diversion to evaluate the impact of fluid administration on postoperative complications assessed 30 days after surgery. Patients were categorized based on the type of urinary diversion (ureterocutaneostomy or ileal conduit) and the volume of intraoperative fluids administered (less than or more than 1000 mL). The results showed that administering more than 1000 mL of fluids was initially associated with an increased risk of complications, but this association lost statistical significance after adjusting for surgery duration and BMI. Indices such as the absolute Vascular Bed Filling Index (aVBFI) and the adjusted Vascular Bed Filling Index (adjVFBI) revealed differences in complication severity 30 days after surgery depending on the type of urinary diversion and fluid management strategy.

Abstract: Introduction: Intravenous fluid management is integral to perioperative care, particularly under enhanced recovery after surgery (ERAS) protocols. In radical cystectomy (RC), which carries high risks of complications and mortality, optimizing fluid management poses a significant challenge due to the absence of definitive guidelines. **Aim:** the purpose of this study was to investigate the effects of intravenous fluid administration on postoperative complications in patients undergoing RC. **Material and methods:** This study involved 288 patients who underwent laparoscopic RC and urinary diversion from 2018 to 2022. ERAS protocols were implemented for all patients. Participants were divided into four groups based on the type of urinary diversion (ureterocutaneostomy vs. ileal conduit) and the intraoperative fluid volume input (less than 1000 mL vs. more than 1000 mL). Postoperative complications were evaluated at 30 and 90 days post-surgery using the Clavien-Dindo scale. The fluid management effectiveness was measured using the absolute Vascular Bed Filling Index (aVBFI) and the adjusted Vascular Bed Filling Index (adjVFBI). **Results:** The UCS is associated with a lower risk of increased severity of postoperative com-plications. The administration of more than 1000 mL of fluids was associated with a higher risk of complications (p = 0.035). However, after adjusting for the duration of the surgery and BMI, this association did not hold statistical significance, indicating that fluid volume alone is not a direct predictor of postoperative complications. At aVBFI values between

zero and eight, urinary diversion using the UCS method is associated with a lower risk of complications compared to the IC. When aVBFI equals eight, the differences in the severity of complications between the UCS and the IC are minimal. However, when aVBFI exceeds eight, the IC is associated with fewer complications during the 30 days post-operation compared to the UCS. The correlation between the adjVFBI (B = −0.27; 95% CI: −0.45 to −0.08; p = 0.005) and the severity of complications up to 30 days postoperatively is similar to that seen with the aVBFI. Similarly, the correlation of the adjVFBI with the method of urinary diversion (B = 0.24; 95% CI: 0.06 to 0.43; p = 0.011) resembles that of the aVBFI. The volume of fluids administered and the indices aVBFI and adjVFBI did not influence the occurrence of complications 90 days postoperatively. **Conclusions:** The volume of fluids administered is not a factor directly affecting the occurrence of complications following RC when the ERAS protocol is used. The amount of intraoperative fluid administration should be adjusted according to the intraoperative blood loss. Our findings endorse the utility of aVBFI and adjVFBI as valuable tools in guiding fluid therapy within the framework of ERAS protocols. However, further multicenter randomized trials are needed to definitively determine the best fluid therapy regimen for patients undergoing RC.

Keywords: radical cystectomy; bladder cancer; ERAS protocol; fluid therapy

1. Introduction

Intravenous fluid restoration is an essential part of perioperative and postoperative care. Adequate intravenous fluid administration maintains proper water and electrolyte balance. The optimal amount of intravenous fluids during and after general surgery still remains undefined [1]. Previous studies have revealed that personalized perioperative fluid management has improved the duration of postoperative ileus (with a lower complication rate) [1,2]. According to some surgical guidelines, fluid intake should be restricted to a maximum of 3 L on the day of surgery [3].

It is worth noting that a restricted postoperative fluid regime reduces complications and postoperative hospital stay after surgery, especially when using the ERAS (Enhanced Recovery After Surgery) protocol [4,5]. Upon achieving promising results in general surgery, the ERAS protocol also began to be implemented in patients undergoing urological procedures. Radical cystectomy (RC) remains the gold standard for treating muscle-invasive urinary bladder cancer, but it is associated with a significant risk of complications and mortality [6–8]. It is worth noting that LND is associated with higher perioperative morbidity and mortality in patients with muscle-invasive bladder cancer undergoing radical cystectomy. Moreover, extended LND did not result in improved disease-free or overall survival in comparison with standard LND [9]. Moreover, Pfail et al. [10] showed that patients with muscle-invasive bladder cancer and with clinically positive lymph nodes, especially in N2-N3 disease, require a tailored approach. While neoadjuvant chemotherapy followed by radical cystectomy is standard for N1 disease, the role of surgery in advanced nodal stages is growing because of better patient selection and treatment strategies [10]. Neoadjuvant chemotherapy improves cancer-specific mortality (CSM) compared to RC alone, both in organ- and non-organ-confined urinary bladder cancer [11]. Additionally, de Angelis et al.'s [12] study showed that neoadjuvant chemotherapy before RC does not result in a statistically significant CSM benefit relative to RC followed by adjuvant chemotherapy. The implementation of the ERAS protocol for patients undergoing RC can reduce the hospitalization time and may improve the cancer-specific survival (CCS) and the 5-year overall survival (OS) [13–16]. Moreover, meta-analyses demonstrate that applying the ERAS

protocol in patients undergoing RC reduces the complication rate and accelerates the return of bowel function [17]. The introduction of less invasive modern surgical techniques allows for a reduction in hospitalization time and a decrease in the number of complications [18]. While working on the study, we hypothesized that excessive fluid administration during cystectomy could lead to edema of the intestinal-to-intestinal or uretero-intestinal anastomoses, particularly in patients from the ileal conduit group. Additionally, the ERAS protocol and its components are implemented differently across various centers. With this study, we aimed to emphasize the importance of restrictive fluid management and the necessity of considering vascular bed filling.

From a pathophysiological point of view, proper water, electrolyte, protein and acid–base balance is crucial for the quick recovery of patients undergoing major surgery. Thus, restrictive fluid therapy remains an important component of the ERAS protocol.

Currently, knowledge regarding the influence of fluid supply during RC is scarce. Several studies on the optimal method of fluid therapy in patients undergoing RC have been conducted by both anesthesiologists and urologists. Previous randomized clinical trials evaluating various fluid therapy regimens did not conclusively determine the management of fluid therapy in patients undergoing RC for urinary bladder cancer [19–22].

Previous knowledge regarding the effect of fluid therapy during and after RC is still inconclusive.

Therefore, the main purpose of this study was to investigate the effects of intravenous fluid administration on postoperative complications in patients undergoing RC.

2. Materials and Methods

2.1. Study Protocol

Two hundred eighty-eight consecutive patients with muscle-invasive urinary bladder cancer who underwent laparoscopic RC with lymphadenectomy and urinary diversion (ureterocutaneostomy or ileal conduit) from 2018 to 2022 were enrolled in a retrospective cohort study. The same surgeon performed all RCs. In each patient of our cohort who underwent radical cystectomy, lymph node dissection (LND) was performed. The standard LND in muscle-invasive bladder cancer involves the removal of nodal tissue cranially up to the common iliac bifurcation, with the ureter being the medial border, and includes the internal iliac, presacral, obturator fossa and external iliac nodes. The lateral borders are the genitofemoral nerves, caudally the circumflex iliac vein, the lacunar ligament and the lymph node of Cloquet [11]. The cohort included patients of various cancer stages, ages and comorbidities.

Patients after RC were divided into four groups based on the urinary diversion technique [ureterocutaneostomy (UCS) and ileal conduit (IC)] and the amount of intravenous fluid (crystalloids) administration [< or >1000 mL], as follows: (1) group 1 [UCS + fluid intake < 1000 mL], (2) group 2 [UCS + fluid intake > 1000 mL], (3) group 3 [IC + fluid intake < 1000 mL] and (4) group 4 [IC + fluid intake > 1000 mL].

ERAS protocols were implemented in each patient who underwent RC, incorporating both preoperative and postoperative measures.

Preoperative measures included promoting increased physical activity and a high-protein diet approximately four weeks prior to RC. No bowel preparation or enemas were used. Carbohydrate- and electrolyte-rich fluids were administered the day before and the morning of the surgery to mitigate insulin resistance. Perioperatively, gabapentin was employed as a co-analgesic. Postoperative management allowed fluid intake on the day of surgery, with oral nutrition initiated on the first postoperative day. Gastric tubes were not used postoperatively, and the route of drug administration was switched to the oral route as tolerated. Low-molecular-weight heparin was administered for thromboprophylaxis.

The collected data included gender, age, body mass index (BMI), Charlson comorbidity index (CCI), nutrition scale (nutrition risk screening, NRS), anesthesiological risk using the ASA (American Society of Anesthesiologists) score, baseline hemoglobin levels and the presence of comorbidities such as hypertension, type 2 diabetes, heart failure, where patients with heart failure were classified as those diagnosed with a reduced left ventricular ejection fraction (LVEF) of <50% during cardiological evaluation, and chronic kidney disease.

Several parameters closely related to the surgical procedure, such as the operation time, blood loss and the method of urinary diversion (UCS or IC) were also taken into account.

These groups were compared in terms of complications at 30 and 90 days post-surgery, and 30- and 90-day post-surgery complications and their relationships were assessed in all experimental groups. Complications were assessed using the Clavien-Dindo scale.

In assessing complications, the ratio of the volume of fluids administered relative to body weight (mL/kg), BMI (mL/kg/m^2), duration of the procedure and combined ratio, taking into account procedure time and body weight (mL/hour/kg), were used. Additionally, two novel clinical parameters were introduced (see Section 2.2).

Propensity score matching (PSM) was conducted to balance baseline characteristics between the UCS group (n = 240) and the ileal conduit diversion group (n = 48). To achieve covariate balance between the groups, the validity of subsequent comparisons was enhanced. PSM was implemented using a nearest-neighbor matching algorithm with a 1:1 matching ratio, ensuring that each patient in the IC group was matched with one patient from the UCS group based on similar propensity scores. The propensity scores were estimated using a logistic regression model, with patient age, CCI (Charlson Comorbidity Index) and clinical tumor stage as predictors.

2.2. Novel Clinical Parameters

Due to the high heterogeneity of patients undergoing RC related to different patient weights and operation time (which is influenced, among others, by the type of urinary diversion), we have defined two novel clinical parameters (aVBFI and adjVFBI), which allow for the unification of experimental groups, allowing for a reliable comparison between groups.

The absolute Vascular Bed Filling Index (aVBFI) assesses vascular bed filling during the procedure. The aVBFI is calculated as the ratio of fluids administered during the procedure due to blood loss.

The adjusted Vascular Bed Filling Index (adjVFBI) is a more accurate parameter than aVBFI because it also considers the procedure's duration. The adjVFBI is calculated as the ratio of the aVBFI to the duration of the procedure in minutes.

Moreover, in further analysis, we assumed that fluid loss through evaporation, respiration and convection remains constant, and that in laparoscopic interventions, it is not as significant as in open surgeries.

2.3. Statistical Analysis

Data analysis was conducted, adhering to rigorous methodological and statistical standards, with a significance level set at $\alpha = 0.05$, which is standard in biomedical sciences, minimizing the risk of Type I error. Descriptive statistics tailored to the type of data were utilized. For quantitative variables, the median was used as it is less sensitive to outliers than the arithmetic mean, and the first and third quartiles were presented, allowing for a fuller understanding of the data distribution.

For categorical variables, the number of observations and percentages were used, facilitating the interpretation of the distribution. To assess the significance of differences between groups, the Wilcoxon rank-sum test was used for quantitative variables and the

Pearson Chi-square test, Fisher's exact test or a proportions test for categorical variables, depending on the sample size and data characteristics.

A multivariate analysis was conducted using a multiple regression model to identify factors affecting the severity of postoperative complications, enabling the assessment of relationships between multiple independent and dependent variables. A robust estimator (M-Huber) that is less sensitive to outliers was used in the analysis, ensuring greater reliability of the results.

The analysis provides information on the risk profile and enables the identification of high-risk groups as well as risk factors that can be targeted for intervention to improve treatment outcomes. The statistical analysis results are presented with 95% confidence intervals and p-values, allowing for the precise interpretation of the strength and direction of the statistical relationships.

Propensity score matching analyses were conducted using the R Statistical language (version 4.3.3; R Core Team, 2024) on Windows 11 pro 64 bit (build 22631), using the packages cobalt (version 4.5.5; Greifer N, 2024), MatchIt (version 4.5.5) [23].

3. Results

3.1. Characteristics of Experimental Groups

The median age of the patients was 68.5 years (63 to 74 years). The gender distribution in the study group showed a significant predominance of males, who comprised 78.1% (225 patients), compared to females, who accounted for 21.9% (63 patients). The median body weight of the patients was 80 kg (70 to 89 kg). The median BMI was 26.95 kg/m^2 (24.30 to 30.05 kg/m^2). Ureterocutaneostomy and ileal conduit were conducted in 240 and 48 patients, respectively.

The hospitalization stay was 10 days (8 to 13 days). The duration of hospitalization did not differ significantly between all experimental groups (p = 0.153).

Hypertension (HT) was the most common comorbidity, which affected 65.3% of all patients. In patients with IC, the incidence of HT was lower at 54.1% compared to the group with UCS, which had a prevalence of 67.5%. However, this difference did not reach statistical significance (p = 0.077). Diabetes mellitus (DM) was present in 24.7% of the participants, with a slightly higher frequency in the patients with IC (29.2%) compared to the patients with UCS (23.8%), although this difference was also not statistically significant (p = 0.427). Similarly, the incidence of heart failure (HF) did not differ significantly between groups, with 14.6% in the IC and 19.1% in the UCS patients (p = 0.454). In our cohort, a statistically significant difference was observed in the case of chronic kidney disease (CKD). In the group of patients after IC, the percentage of patients with CKD was significantly lower (8.3%) compared to the patients with UCS (30%), with a p-value of 0.002. (Table 1)

Patients in the IC group were statistically younger than those in the USC group. The median age for the IC group was 64 years, compared to 69 years for the USC group (p < 0.001).

According to the Charlson comorbidity index (CCI) results, the majority of patients (59.7%) had a score greater than four, suggesting the presence of comorbid conditions that worsen the prognosis. A statistically significant difference (p < 0.001) between urinary diversion techniques indicates that a higher percentage of patients with ileal conduit had a better CCI outcome (<4) (64.6%) compared to the patients with UCS (35.4%).

For older and comorbid patients, the uretero-ureterocutaneous fistula (UCN) without the use of intestinal interposition devices is an alternative and safe procedure [24]. In our population of 417 patients, the operation time (incision–suture time: median 82 min; range 63–121 min) and mortality (2.1%) are low despite a pronounced negative selection of

comorbid in elderly patients (mean age 79 years). A potential disadvantage compared to the ileum conduit is the obligatory ureteral splinting.

Table 1. Characteristics of the study group.

Characteristic *N=288*	*Overall in sample*[a]	Urinary Diversion		*p*[b]
		IC[a], *n = 48*	*UCS*[a], *n = 240*	
Hipertension	188 (65.28%)	26 (54.2%)	162 (67.5%)	0.077
Diabetes Mellitus	71(24.65%)	14(29.2%)	57 (23.8%)	0.427
Heart Failure	53(18.40%)	7 (14.6%)	46 (19.2%)	0.454
Chronic Kidney Disease	76(26.39%)	4 (8.3%)	72 (30.0%)	**0.002**
Neoadjuvant chemotherapy	44 (15.3%)	5 (10.4%)	39 (16.3%)	0.305[b]
cTNM:				
cT2	101 (35.1%)	25 (52.1%)	76 (31.7%)	**0.007**[d]
cT3	118 (41.0%)	20 (41.7%)	98 (40.8%)	0.915[d]
cT4	68 (23.6%)	2 (4.2%)	66 (27.5%)	**0.001**[c]

[a] n (%); [b] Pearson Chi-square test; [c] Fisher's exact test; [d] proportions test.

The assessment of the ASA scale score revealed significant differences between the groups (p = 0.004). In the patients with IC, a larger percentage of patients had a lower risk class, ASA2 (41.7%), compared to the UCS patients (19.2%), while the higher risk class, ASA3, was more common in the UCS patients (79.2%) than in the IC patients (58.3%). The NRS (nutritional risk score) also showed a statistically significant difference (p = 0.022), with the median score in the IC patients being lower than that in the UCS patients.

The study observed a statistically significant difference in preoperative hemoglobin (HGB) levels between the groups, where patients with IC creation had a higher median HGB (13.80 g/dL) compared to the patients with UCS (12.30 g/dL). The differences remained significant postoperatively, with higher HGB in the IC patients (11.95 g/dL) compared to the UCS patients (10.65 g/dL). The loss of hemoglobin did not differ significantly between the groups.

The use of neoadjuvant chemotherapy (CHTx) in this cohort was relatively low, at 15.3% (44 individuals)—5 patients from the IC group (10.4%) and 39 patients from the UCS group (16.3%). The neoadjuvant CHTx used for our patients was based on cisplatin agents.

The low percentage of patients receiving neoadjuvant chemotherapy results from the significant comorbidity of the Polish population compared to other European populations [25]. Scientific reports indicate that the risk of malnutrition in the Polish population over 65 years old can reach 44.2% [26] and 39.2% in the oncological patient group [27]. The prevalence of overweight is 63% in men and 43% in women [28]. This also explains why the simplest form of urinary diversion is often chosen after cystectomy (CR).

The results indicate statistically significant differences ($p < 0.05$) in terms of clinical tumor stage (cT). In the UCS group, individuals with advanced cT4 tumors constituted 27.5%, while the patients with IC constituted only 4.17% (p = 0.001). (Table 1) A higher proportion of patients in the UCS group was suspected of having lymph node metastases compared to the IC group (13.3% vs. 2.1%, p = 0.025). Patients in the IC group more frequently had organ-confined disease (cT2)—52.1%, compared to 31.7% in the UCS group (p = 0.007). The percentage of patients with cT3 advancement did not differ significantly between the groups, wit 41.6% in the IC group and 40.1% in the UCS group (p = 0.915).

However, the presence of hydronephrosis was significantly less common in the IC group (10.4%) compared to the UCS group (34.2%) [p = 0.001].

Preventing infections, including wound infections, appears to play a crucial role during radical cystectomy and in the perioperative period. Infectious complications can account for up to 25% of complications following radical cystectomy procedures during RARC [29]. If open access is used during radical cystectomy (ORC), the use of Alexis wound protectors has been shown to effectively reduce the rate of postoperative wound infections [30]. In our study, all procedures were performed laparoscopically, and we used standard extraction bags. We observed only incidental cases of wound infections or pneumonia after laparoscopy.

The median operation time was 200 min (from 175 to 241 min.). The duration of the procedure was significantly longer in the group of patients using the IC creation (average 260 min.) compared to the UCS creation (average 190 min.; $p < 0.001$). The median blood loss was 250 mL (ranging from 150 to 350 mL). Concurrently, there was no significant difference in blood loss between the UCS and IC groups (p = 0.962). (Table 2).

Table 2. Parameters of perioperative factors in the sample, stratified by urinary diversion technique after cystectomy.

Charactreristic	*N=288*	*Overall in sample*[a]	Urinary Diversion		*p*[c]
			IC[a]*,n = 48*	*UCS*[a]*,n = 240*	
Surgery time min		200 (175 – 241)	260 (242 – 285)	190 (165 – 220)	**< 0.001**
Blood loss mL		250 (150 – 350)	250 (200 – 350)	250 (150 – 350)	0.962
Fluids Administrated During Surgery mL		1 000 (500 – 1 900)	1 350 (800 – 1 900)	1 000 (500 – 1 900)	**0.011**
Fluids Administrated/ Surgery time /Weight mL/hr/kg		4.28 (3.34 – 5.41)	3.69 (2.55 – 4.60)	4.41 (3.58 – 5.79)	**< 0.001**
Fluids/BMI ml/kg/m2		140.5 (124.0 – 158.0)	143.0 (124.0 – 152.25)	140.0 (124.0 – 159.25)	0.998
aVBFI (1)		4.80 (3.18 – 7.04)	5.00 (3.63 – 8.08)	4.33 (3.0 – 7.0)	0.107

[a] *Mdn* (*Q1*, *Q3*); [b] *n* (%); [c] Wilcoxon rank-sum test

The ratio of fluids administered per hour of surgery per kilogram of body weight (mL/hour/kg) was significantly lower in the IC group (3.69) compared to the UCS group (4.41; $p < 0.001$).

This may be due to the fact that patients in the IC group statistically weighed more than those in the USC group—84 kg vs. 79 kg (p = 0.011). However, no differences between the groups were noted after calculating the BMI.

The rate of blood product transfusions was higher in the UCS group (34.2%) than in the IC group (14.6%; p = 0.007). No statistically significant differences were observed in the percentage of patients requiring intensive care unit support (p = 0.228).

There was a statistically significant difference in the incidence of ileus (p = 0.001), with a higher frequency of cases in the IC group (27.1%) compared to the UCS group (9.6%).

3.2. Postoperative Complications According to the Clavien-Dindo Classification Within 30 Days

The frequency of complications, as measured by the Clavien-Dindo scale, did not differ significantly, regardless of the method of urinary diversion or the amount of fluids administered. The distribution of complications in each group is attached in Table 3.

Table 3. Complications depending on the type of urinary diversion type.

Characteristic	N	Overall in Sample [a]	Urinary Diversion		p [b]
			IC [a], n = 48	UCS [a], n = 240	
Clavien-Dindo 30 days	288				0.354
1		126 (43.8%)	19 (39.6%)	107 (44.6%)	
2		70 (24.3%)	19 (20.8%)	60 (25.0%)	
3a		37 (12.9%)	8 (16.7%)	29 (12.1%)	
3b		32 (11.1%)	9 (18.8%)	23 (9.6%)	
4		6 (2.1%)	0 (0.0%)	6 (2.5%)	
5		8 (2.8%)	0 (0.0%)	8 (3.3%)	
Clavien-Dindo 90 days	280				0.176
1		46 (16.4%)	4 (8.3%)	42 (18.1%)	
2		71 (25.4%)	11 (22.9%)	60 (25.9%)	
3a		29 (10.4%)	8 (16.7%)	21 (9.0%)	
3b		4 (1.4%)	1 (2.1%)	3 (1.3%)	
4		1 (0.4%)	0 (0.0%)	1 (0.4%)	
5		11 (3.9%)	0 (0.0%)	11 (4.7%)	

[a] n (%); [b] Fisher's exact test.

However, several factors that influence the severity of complications were identified (Table 4).

Table 4. Factors determining the complications 30 days after RC.

Explanatory Variables	Severity of Complications (Clavien-Dindo)		
	B	CI 95%	p
Age years	0.01	−0.01–0.03	0.283
BMI kg/m^2	−0.03	−0.06–−0.00	0.045
Fluids administrated (>1000 mL)	0.28	0.02–0.54	0.035
Fluids to surgery time to patient weight ratio ml/hr/kg	−0.04	−0.11–0.04	0.337
Neoadjuvant CHTx	−0.00	−0.30–0.30	0.999
Hypertension	0.11	−0.14–0.36	0.396
Diabetes mellitus	0.08	−0.19–0.35	0.572
Heart failure	−0.07	−0.37–0.24	0.669
Chronic kidney disease	0.11	−0.19–0.41	0.467
Hydronephrosis	0.09	−0.17–0.36	0.476
Acute kidney injury	0.11	−0.13–0.36	0.358
Urinary diversion (IC) *	-	-	-
Urinary diversion (UCS)	−0.53	−0.99–−0.07	0.024
aVBFI	−0.07	−0.12–−0.03	0.002
adjVBFI	−0.27	−0.45–−0.08	0.005
Transfusion	0.24	−0.04–0.51	0.092
Hospitalization days	0.02	0.00–0.03	0.011
Reoperation	2.11	1.78–2.44	<0.001
aVBFI × Urinary diversion (UCS)	0.07	0.02–0.12	0.011
adjVBFI × Urinary diversion (UCS)	0.24	0.06–0.43	0.011

Annotations: B—regression model coefficient; CI 95%—confidence interval 95%; p—p-value of the statistical test. *—No value is given for the urinary diversion (IC) variable because urinary diversions were compared to each other.

The administration of fluid volumes above 1000 mL is associated with a higher severity of complications (p = 0.035) within 30 days post-surgery when not accounting for additional factors such as the duration of the operation and patient weight. However, the lack of statistical significance in this area after adjusting the volume of administered fluids for the duration of the operation and patient BMI indicates that fluid volume alone is not a reliable predictor of the severity of complications after RC. Using the UCS after RC is associated with less severe complications according to the Clavien-Dindo scale, suggesting its potential benefits in a postoperative context (B = −0.53, p = 0.024). However, the significance of this variable becomes more complex when considering its interaction with the absolute Vascular Bed Filling Index (aVBFI). A direct comparison of the four experimental groups, based solely on the number of fluids administered (< or >1000 mL), showed no differences.

However, after applying the aVBFI, it was found that there was a significant interaction between aVBFI and the type of urinary diversion (UCS/IC) (B = 0.07, p = 0.011).

At aVBFI values between zero and eight, urinary diversion using the UCS is associated with a lower risk of complications compared to the IC. When aVBFI equals eight, the differences in the severity of complications between the UCS and the IC are minimal. However, when aVBFI exceeds eight, the IC creation is associated with fewer complications within 30 days postoperatively compared to UCS (Figure 1) .

The correlation between the adjusted Vascular Bed Filling Index (adjVFBI) (B = −0.27; 95% CI: −0.45 to −0.08; p = 0.005) and the severity of complications up to 30 days post-operatively is similar to that seen with aVBFI. Similarly, the correlation of adjVFBI with the method of urinary diversion (B = 0.24; 95% CI: 0.06 to 0.43; p = 0.011) resembles that of aVBFI.

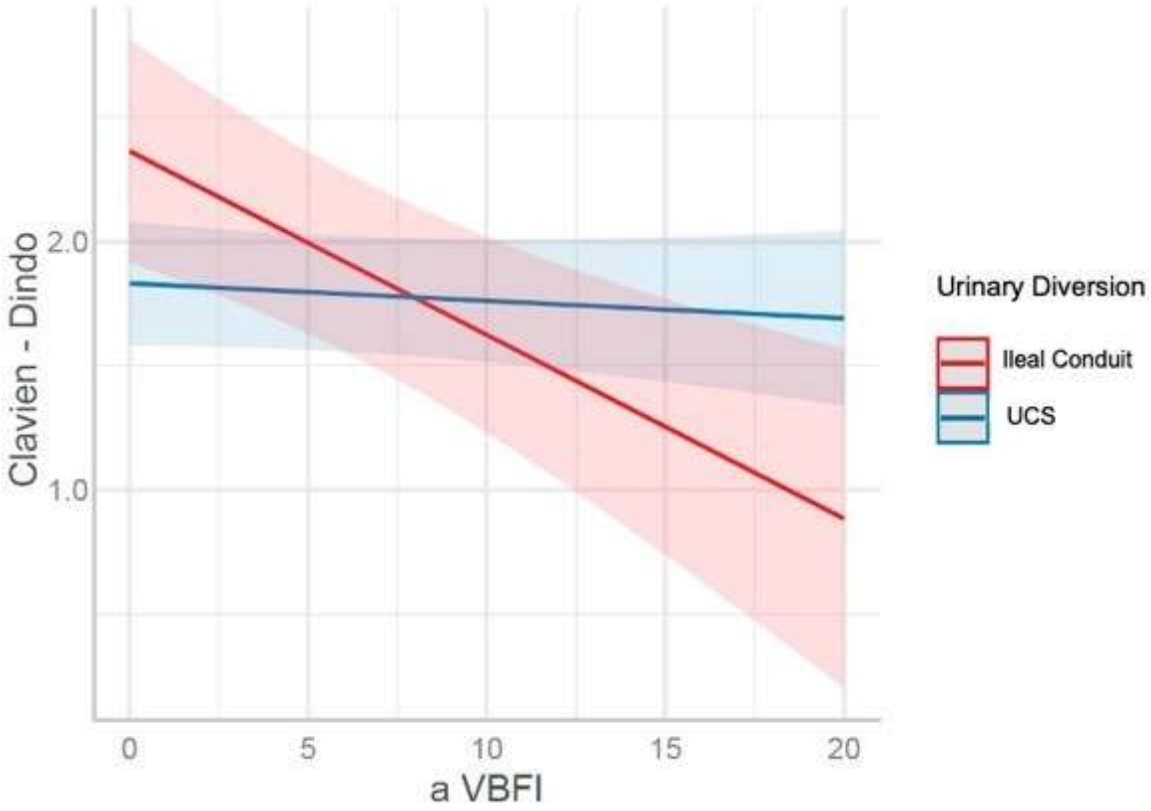


Figure 1. The interaction effect between aVBFI and the urinary diversion on the severity of complications using the Clavien-Dindo scale one month after RC.

3.3. Complications According to the Clavien-Dindo Classification After 90 Days

The different amounts of intravenous fluid administration did not influence the severity of complications in 90 days postoperatively.

The statistical analysis based on two hundred and eighty observations (eight patients died before reaching 90 days post-surgery) indicated that the occurrence of acute kidney injury in the postoperative period was associated with a higher degree of complication severity (B = 0.40; 95% CI: 0.04–0.75; $p = 0.028$). A longer hospitalization time was also significantly associated with a higher degree of complication severity (B = 0.04; 95% CI: 0.02–0.06; $p < 0.001$). No significant associations were observed between other factors and complications after 90 days from the procedure.

3.4. Propensity Score Matching

The propensity score matching procedure was successful in balancing covariates between the UCS group and the ileal conduit diversion group. Prior to matching, significant imbalances were observed across several covariates. For instance, the standardized mean differences (SMD) indicated substantial differences in age (SMD = −0.80), CCI scale ("good" vs. "burdened" SMD = 0.61 and −0.61, respectively) and tumor stage, particularly for cT4 (SMD = −1.17). These imbalances suggest that patients in the UCS group were older, had a higher burden of comorbidities and were more likely to present with advanced tumor stages compared to the ileal conduit group.

After matching, covariate balance improved considerably. The standardized mean differences for all covariates were reduced to within acceptable thresholds, with SMD values for age (−0.08), CCI categories (0.00 for both ("good" vs. "burdened") and tumor stages (e.g., cT1-cT2: SMD = 0.13, cT3: SMD = −0.17, cT4: SMD = 0.10) indicating minimal residual imbalance. The mean difference in propensity scores between the groups was also reduced (SMD = 0.05), reflecting the successful alignment of treatment probabilities between the matched groups. The variance ratios for continuous variables, such as age (0.72), and eCDF differences for categorical variables (all ≤0.13) further confirm improved balance post-matching (see Figure 2 for visualized covariate balance).

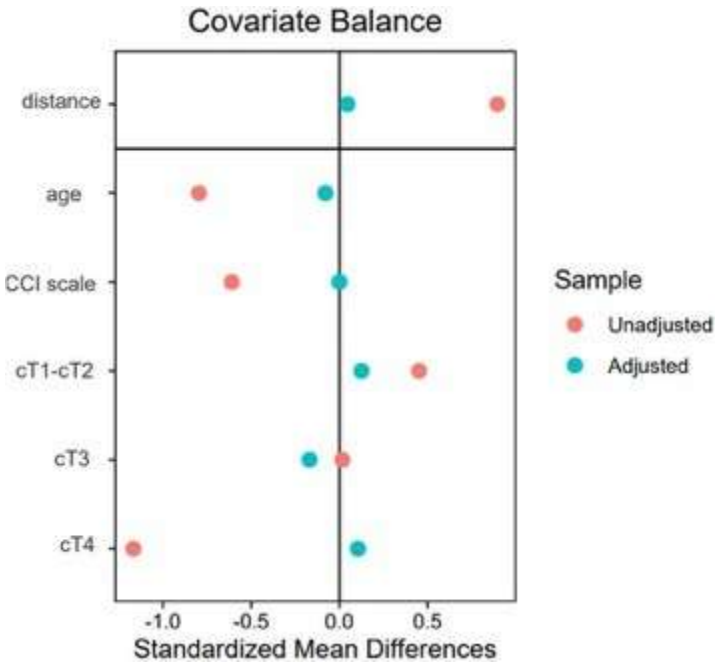


Figure 2. Standardized mean differences for covariate balance before and after propensity score matching.

The matching process retained all 48 patients in the ileal conduit group and matched them to 48 patients in the UCS group, reducing the control group from 240 to 48 for direct comparisons. This ratio ensured equal representation of both groups in the matched dataset, minimizing bias in subsequent analyses. Importantly, no patients were discarded or excluded due to extreme propensity scores, indicating that overlap in treatment probabilities was sufficient for reliable matching.

These results imply that the matched dataset provides a robust basis for comparing outcomes between the UCS and IC groups, free from the confounding influences of age, comorbidities and tumor stage. The improved balance after matching allows for more accurate estimation of the effect of urinary diversion type on patient outcomes, without the bias introduced by baseline differences between the groups.

The assessment of the impact of the urinary diversion method using the covariate balance sample (N = 96, n IC = n UCS = 48) reproduced the results of the previously reported regression models. The UCS diversion was associated with a significantly lower severity of complications one month after surgery (B = −0.51, 95% CI: −0.99–−0.03, p = 0.036) compared to the IC diversion. However, the urinary diversion method did not have a significant effect on the Clavien-Dindo parameter at three months post-surgery (p = 0.415).

4. Discussion

The results of this study indicate that the amount of intravenous fluids administration as an isolated parameter does not correlate with the severity of early and late postopera-tive complications after RC. The significant effects observed with newly defined clinical parameters such as absolute and adjusted Vascular Bet Filling Index (aVBFI and adjVBFI) suggest that the appropriate ratios of fluid resuscitation relative to blood loss are crucial for improving postoperative outcomes and can effectively reduce the severity of complications. Our findings also suggest that simpler methods of urinary diversion should be considered during procedures associated with significant blood loss.

In various single-center studies of radical cystectomy, the incidence of complications remains high even when tumors are slightly less advanced. Additionally, the rate of blood transfusions has been reported to be as high as 54.8%, as detailed in the study by Anil Erdik et al. [31].

Bazargani et al. [19] found no correlation between the amount of perioperative fluids input (including crystalloids, colloids, and blood products) and complications at 30 and 90 days post-surgery in 180 patients after open RC. Additionally, fluid administration did not affect the length of hospital stay.

On the other hand, Wuetrich et al. [32] randomized 166 patients into two groups and demonstrated that reduced fluid administration at a rate of 3 mL/kg/hour during surgery, combined with intraoperative noradrenaline infusion, reduced complications by 21% (52% vs. 73%) compared to administering 6 mL/kg/hour without noradrenaline. This approach also decreased the risk of death within 90 days after RC by 4.8% (0% vs. 4.8%). However, their study did not utilize the ERAS protocol, whose components may positively influence the frequency of complications and postoperative stress. This might be the reason for conflicting results regarding fluid therapy alone in these patients.

Similarly, Furrer et al.'s [33] study, in a group of 775 patients undergoing RC without the ERAS protocol, demonstrated that a reduced crystalloid administration of 3.5 vs. 4.2 mL/kg body weight during the procedure may contribute to developing postoperative renal failure. However, no effect of colloids on postoperative renal failure was demonstrated.

Studies emphasize that fluid administration should be individualized and based on objective measurements of flow rates to achieve optimal preload values. This involves

adjusting fluid delivery according to the filling of the vascular bed, which can be monitored using tools like an esophageal Doppler probe placed in the patient. Goal-directed fluid therapy (GDFT) has been particularly studied in terms of the recovery of gastrointestinal (GI) function after surgical procedures, and several meta-analyses have been conducted on this topic.

Giglio and colleagues analyzed 16 studies and demonstrated that GDFT reduces the frequency of severe GI complications compared to the control groups [34]. Additionally, Gomez-Isquierdo et al. [1] concluded that GDFT decreases the incidence of postoperative nausea and vomiting, allows patients to tolerate a diet sooner and shortens the time to the first bowel movement. These benefits did not extend to patients who were managed under the ERAS protocol. Also, Srinivasa et al. [35] analyzed 691 patients where GDFT was combined with the ERAS protocol in colorectal surgery and found no differences in complications or length of hospital stay among the patients.

The impact of GDFT has also been studied in patients with urinary bladder cancer undergoing RC. After analyzing two fairly large groups of patients who underwent open RC, where GDFT was applied in the experimental group without the ERAS protocol, Arslan-Carlon et al. [22] did not demonstrate a positive impact of this fluid therapy approach on either intestinal function or the number of high-grade postoperative complications. They observed a higher risk of acute kidney injury (AKI) in patients from the GDFT group. On the other hand, Pillai and colleagues demonstrated that using GDFT in patients undergoing RC reduces GI complications and improves wound healing [2]. However, the experimental and control groups were small; the procedure duration significantly differed between groups, and the ERAS protocol was not implemented in this study.

Ghoreifi et al. [20] studied the application of GDFT in patients undergoing RC and the ERAS protocol implementation. They evaluated kidney function, the length of stay, complications and rehospitalization 90 days post-surgery. No significant differences were found between the experimental and control groups. Additionally, stroke volume variation (SVV) was studied by Kong et al. [21] in patients undergoing RC. SVV is gaining increasing attention as a reliable index for protocolized fluid management (specifically maintaining SVV within the 10–20% range) to minimize vascular congestion in surgical areas and intraoperative blood loss during procedures such as living-donor hepatectomy. However, this study did not show the impact of this method of fluid transfusion on postoperative outcomes. Nevertheless, it did help to reduce blood loss and the number of transfusions of blood products.

The results of the studies presented above are conflicting, yet they suggest that intra-operative fluid administration based on the filling of the vascular bed or blood loss may influence the complications following RC.

We would also like to mention that a limitation of our study is the retrospective nature of the data analysis. We also did not exclude patients with advanced cancer or those undergoing palliative cystectomy from the analysis. The group of patients in whom urinary diversion was performed using the IC is significantly smaller, and these patients had lower CCI scores and initial cancer staging. Patients in the UCS group also had a higher risk of malnutrition, which is an independent risk factor for the occurrence of complications 30 days after the procedure [36]. However, comparing the results of our study with those of other researchers suggests that optimizing fluid administration based on the filling of the vascular bed could have a positive impact on complications in patients undergoing RC together with the application of the ERAS protocol.

Additionally, it seems that newly defined clinical parameters, such as absolute and adjusted Vascular Bed Filling Index (aVBFI and adjVBFI), seem useful in everyday urological practice in assessing the risk of postoperative complications after RC.

5. Conclusions

The volume of fluids administered does not directly affect the severity of complications following RC when the ERAS protocol is used. The amount of intraoperative fluid administration should be adjusted according to the intraoperative blood loss. In procedures with significant blood loss, simpler methods of urinary diversion should be considered.

The findings endorse the utility of novel clinical parameters such as aVBFI and adjVBFI as valuable clinical tools in guiding fluid therapy within the framework of ERAS protocols. However, further multicenter randomized trials are needed to definitively determine the best fluid therapy regimen for patients undergoing RC.

Author Contributions: Conceptualization, P.L. and T.D.; methodology, P.L. and K.J. and A.O.; software, A.O. and F.K.; validation, T.D., K.J. and J.A.; formal analysis, P.L. and A.O.; investigation, P.L.; resources, P.J.; data curation, P.L.; writing—original draft preparation, P.L.; writing—review and editing, K.J, T.D., A.O. and J.A.; visualization, A.O., F.K., P.J.; supervision, K.J., T.D.; project administration, P.L. and K.J. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee.

Informed Consent Statement: Patient consent was waived due to inability to identify the patient in this study and retrospective nature of the study.

Data Availability Statement: Data is contained within the article.

Conflicts of Interest: The authors declare no competing interests.

References

1. Gõmez-Izquierdo, J.C.; Feldman, L.S.; Carli, F.; Baldini, G. Meta-analysis of the effect of goal-directed therapy on bowel function after abdominal surgery. *Br. J. Surg.* **2015**, *102*, 577–589. [CrossRef]
2. Pillai, P.; McEleavy, I.; Gaughan, M.; Snowden, C.; Nesbitt, I.; Durkan, G.; Johnson, M.; Cosgrove, J.; Thorpe, A. A double-blind randomized controlled clinical trial to assess the effect of doppler optimized intraoperative fluid management on outcome following radical cystectomy. *J. Urol.* **2011**, *186*, 2201–2206. [CrossRef]
3. Schwenk, W.; Flemming, S.; Girona-Johannkämper, M.; Wendt, W.; Darwich, I.; Strey, C. Structured implementation of fast-track pathways to enhance recovery after elective colorectal resection: First results from five German hospitals. *Chirurgie* **2024**, *95*, 148–156. [CrossRef] [PubMed]
4. Gustafsson, U.O.; Hausel, J.; Thorell, A.; Ljungqvist, O.; Soop, M.; Nygren, J. Adherence to the enhanced recovery after surgery protocol and outcomes after colorectal cancer surgery. *Arch. Surg.* **2011**, *146*, 571–577. [CrossRef] [PubMed]
5. Brandstrup, B.; Tønnesen, H.; Beier-Holgersen, R.; Hjortsø, E.; Ørding, H.; Lindorff-Larsen, K.; Rasmussen, M.S.; Lanng, C.; Wallin, L.; Iversen, L.H.; et al. Effects of Intravenous Fluid Restriction on Postoperative Complications: Comparison of Two Perioperative Fluid Regimens—A Randomized Assessor-Blinded Multicenter Trial. *Ann. Surg.* **2003**, *238*, 641–648. [CrossRef] [PubMed]
6. Nielsen, M.E.; Mallin, K.; Weaver, M.A.; Palis, B.; Stewart, A.; Winchester, D.P.; Milowsky, M.I. Association of hospital volume with conditional 90-day mortality after cystectomy: An analysis of the National Cancer Data Base. *BJU Int.* **2014**, *114*, 46–55. [CrossRef] [PubMed]
7. Hautmann, R.E.; De Petriconi, R.C.; Volkmer, B.G. Lessons learned from 1,000 neobladders: The 90-day complication rate. *J. Urol.* **2010**, *184*, 990–994. [CrossRef]
8. Stein, J.P.; Skinner, D.G. Radical cystectomy for invasive bladder cancer: Long-term results of a standard procedure. *World J. Urol.* **2006**, *24*, 296–304. [CrossRef] [PubMed]
9. Lerner, S.P.; Tangen, C.; Svatek, R.S.; Daneshmand, S.; Pohar, K.S.; Skinner, E.; Schuckman, A.; Sagalowsky, A.I.; Smith, N.D.; Kamat, A.M.; et al. Standard or Extended Lymphadenectomy for Muscle-Invasive Bladder Cancer. *N. Engl. J. Med.* **2024**, *391*, 1206–1216. [CrossRef] [PubMed]
10. Pfail, J.; Lichtbroun, B.; Golombos, D.M.; Jang, T.L.; Packiam, V.T.; Ghodoussipour, S. The role of radical cystectomy and lymphadenectomy in the management of bladder cancer with clinically positive lymph node involvement. *Curr. Opin. Urol.* **2025**, *35*, 115–122. [CrossRef]

11. de Angelis, M.; Jannello, L.M.I.; Siech, C.; Baudo, A.; Di Bello, F.; Goyal, J.A.; Tian, Z.; Longo, N.; de Cobelli, O.; Chun, F.K.; et al. Neoadjuvant chemotherapy before radical cystectomy in patients with organ-confined and non-organ-confined urothelial carcinoma. *Urol. Oncol. Semin. Orig. Investig.* **2025**, *43*, 62.e1–62.e6. [CrossRef]
12. de Angelis, M.; Siech, C.; Jannello, L.M.I.; Di Bello, F.; Peñaranda, N.R.; Goyal, J.A.; Touma, N.; Tian, Z.; Longo, N.; de Cobelli, O.; et al. Neoadjuvant Versus Adjuvant Chemotherapy in Non-Metastatic Locally-Advanced Stage Radical Cystectomy Candidates. *Clin. Genitourin. Cancer* **2024**, *22*, 102132. [CrossRef] [PubMed]
13. Daneshmand, S.; Ahmadi, H.; Schuckman, A.K.; Mitra, A.P.; Cai, J.; Miranda, G.; Djaladat, H. Enhanced recovery protocol after radical cystectomy for bladder cancer. *J. Urol.* **2014**, *192*, 50–56. [CrossRef] [PubMed]
14. Frees, S.K.; Aning, J.; Black, P.; Struss, W.; Bell, R.; Chavez-Munoz, C.; Gleave, M.; So, A.I. A prospective randomized pilot study evaluating an ERAS protocol versus a standard protocol for patients treated with radical cystectomy and urinary diversion for bladder cancer. *World J. Urol.* **2018**, *36*, 215–220. [CrossRef] [PubMed]
15. Persson, B.; Carringer, M.; Andrén, O.; Andersson, S.O.; Carlsson, J.; Ljungqvist, O. Initial experiences with the enhanced recovery after surgery (ERAS®) protocol in open radical cystectomy. *Scand. J. Urol.* **2015**, *49*, 302–307. [CrossRef] [PubMed]
16. Crettenand, F.; M'baya, O.; Grilo, N.; Valerio, M.; Dartiguenave, F.B.; Cerantola, Y.; Roth, B.; Rouvé, J.-D.; Blanc, C.; Lucca, I. ERAS® protocol improves survival after radical cystectomy: A single-center cohort study. *Medicine* **2022**, *101*, e30258. [CrossRef]
17. Tyson, M.D.; Chang, S.S. *Enhanced Recovery Pathways Versus Standard Care After Cystectomy: A Meta-Analysis of the Effect on Perioperative Outcomes*; Elsevier: Amsterdam, The Netherlands, 2016. [CrossRef]
18. Rahota, R.G.; Beauval, J.-B.; Gautier, J.-R.; Almeras, C.; Garnault, V.; Loison, G.; Salin, A.; Tollon, C.; Ploussard, G. Impact of outcomes and costs for implementation of robotic radical cystectomy with full intracorporeal urinary diversion. *Central Eur. J. Urol.* **2023**, *76*, 305–310. [CrossRef]
19. Bazargani, S.T.; Ghodoussipour, S.; Tse, B.; Miranda, G.; Cai, J.; Schuckman, A.; Daneshmand, S.; Djaladat, H. The association between intraoperative fluid intake and postoperative complications in patients undergoing radical cystectomy with an enhanced recovery protocol. *World J. Urol.* **2018**, *36*, 401–407. [CrossRef] [PubMed]
20. Ghoreifi, A.; Basin, M.F.; Ghodoussipour, S.; Bazargani, S.T.; Amini, E.; Aslzare, M.; Cai, J.; Miranda, G.; Sugeir, S.; Bhanvadia, S.; et al. Perioperative outcomes of goal-directed versus conventional fluid therapy in radical cystectomy with enhanced recovery protocol. *Int. Urol. Nephrol.* **2021**, *53*, 1827–1833. [CrossRef] [PubMed]
21. Kong, Y.G.; Kim, J.Y.; Yu, J.; Lim, J.; Hwang, J.H.; Kim, Y.K. Efficacy and safety of stroke volume variation-guided fluid therapy for reducing blood loss and transfusion requirements during radical cystectomy: A randomized clinical trial. *Medicine* **2016**, *95*, e3685. [CrossRef]
22. Arslan-Carlon, V.; Tan, K.S.; Dalbagni, G.; Pedoto, A.C.; Herr, H.W.; Bochner, B.H.; Cha, E.K.; Donahue, T.F.; Fischer, M.; Donat, S.M. Goal-directed versus standard fluid therapy to decrease ileus after open radical cystectomy: A prospective randomized controlled trial. *Anesthesiology* **2020**, *133*, 293–303. [CrossRef] [PubMed]
23. Ho, D.; Imai, K.; King, G.; Stuart, E.A. MatchIt: Nonparametric Preprocessing for Parametric Causal Inference. *J. Stat. Softw.* **2011**, *42*, 1–28. [CrossRef]
24. Otto, T.; Barski, D.; Karig, R.T. Additions. *Dtsch. Arztebl. Int.* **2021**, *118*, 31–32. [CrossRef] [PubMed]
25. Souza, D.L.B.; Oliveras-Fabregas, A.; Minobes-Molina, E.; de Camargo Cancela, M.; Galbany-Estragués, P.; Jerez-Roig, J. Trends of multimorbidity in 15 European countries: A population-based study in community-dwelling adults aged 50 and over. *BMC Public Health* **2021**, *21*, 76. [CrossRef] [PubMed]
26. Krzyminska-Siemaszko, R.; Chudek, J.; Suwalska, A.; Lewandowicz, M.; Mossakowska, M.; Kroll-Balcerzak, R.; Wizner, B.; Tobis, S.; Mehr, K.; Wieczorowska-Tobis, K. Health status correlates of malnutrition in the polish elderly population—Results of the Polsenior Study. *Eur. Rev. Med. Pharmacol. Sci.* **2016**, *20*, 4565–4573.
27. Grabowska, I.; S´cisło, L.; Pietruszka, S.; Walewska, E.; Paszko, A.; Siarkiewicz, B.; Richter, P.; Budzyński, A.; Szczepanik, A.M. The model of perioperative risk assessment in elderly patients—Interim analysis. *Pol. Merkur. Lekarski.* **2017**, *42*, 151–157. [PubMed]
28. Gajewska, D.; Harton, A. Current nutritional status of the Polish population—Focus on body weight status. *J. Health Inequalities* **2023**, *9*, 154–160. [CrossRef]
29. Lama, D.J.; Okunowo, O.; Yamzon, J.; Zhumkhawala, A.-A.; Wilson, T.G.; Lau, C.S.; Yuh, B.E.; Chan, K.G. Long-term oncologic outcomes and complications of robot-assisted radical cystectomy for the treatment of urothelial carcinoma of the bladder. In *Urologic Oncology: Seminars and Original Investigations*; Elsevier: Amsterdam, The Netherlands, 2024. [CrossRef]
30. Galosi, A.B.; Fave, R.F.D.; Perpepaj, L.; Milanese, G.; Polisini, G.; Mantovan, M.; Brocca, C.; Palantrani, V.; Tramanzoli, P.; Antezza, A.; et al. Does Alexis Wound Protector/Retractor Reduce the Risk of Surgical Site Infections After Open Radical Cystectomy for Bladder Cancer? Results From a Single Center, Comparative Study. *Urology* **2024**, *184*, 162–168. [CrossRef]
31. Erdik, A.; Cimen, H.I.; Atik, Y.T.; Gul, D.; Kose, O.; Halis, F.; Saglam, H.S.; Ates, O.F. Sarcopenia is an independent predictor of survival in patients undergoing radical cystectomy for bladder cancer: A single-centre, retrospective study. *Central Eur. J. Urol.* **2023**, *76*, 81–89. [CrossRef]

32. Wüthrich, P.Y.; Burkhard, F.C.; Thalmann, G.; Stueber, F.; Studer, U. Restrictive Deferred Hydration Combined with Preemptive Norepinephrine Infusion during Radical Cystectomy Reduces Postoperative Complications and Hospitalization Time A Randomized Clinical Trial. *Anesthesiology* **2014**, *120*, 365–377. [CrossRef]
33. Furrer, M.A.; Schneider, M.P.; Loffel, L.M.; Burkhard, F.C.; Wuethrich, P.Y. Impact of intra-operative fluid and noradrenaline administration on early postoperative renal function after cystectomy and urinary diversion. *Eur. J. Anaesthesiol.* **2018**, *35*, 641–649. [CrossRef] [PubMed]
34. Giglio, M.T.; Marucci, M.; Testini, M.; Brienza, N. *Goal-Directed Haemodynamic Therapy and Gastrointestinal Complications in Major Surgery: A Meta-Analysis of Randomized Controlled Trials*; Oxford University Press: Oxford, UK, 2009. [CrossRef]
35. Srinivasa, S.; Lemanu, D.P.; Singh, P.P.; Taylor, M.H.G.; Hill, A.G. Systematic review and meta-analysis of oesophageal Doppler-guided fluid management in colorectal surgery. *Br. J. Surg.* **2013**, *100*, 1701–1708. [CrossRef] [PubMed]
36. Riveros, C.; Jazayeri, S.B.; Chalfant, V.; Ahmed, F.; Bandyk, M.; Balaji, K.C. The Geriatric Nutritional Risk Index Predicts Postoperative Outcomes in Bladder Cancer: A Propensity Score-Matched Analysis. *J. Urol.* **2022**, *207*, 797–804. [CrossRef]

7.3 Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study

ORIGINAL PAPER

Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study

Paweł Lipowski[1*], Adam Ostrowski[1], Jan Adamowicz[1,2], Anastazja Zaigrajewa[1], Przemysław Jasiewicz[3], Filip Kowalski[1], Tomasz Drewa[1], Kajetan Juszczak[1*]

[1]Department of Urology and Andrology, Collegium Medicum, Nicolaus Copernicus University, Bydgoszcz, Poland
[2]Department of Regenerative Medicine, Collegium Medicum, Nicolaus Copernicus University, Bydgoszcz, Poland
[3]Department of Anesthesiology and Intensive Care, Collegium Medicum, Nicolaus Copernicus University, Bydgoszcz, Poland

Citation: Lipowski P, Ostrowski A, Adamowicz J, et al. Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026; doi: 10.5173/ceju.2025.0163

Article history
Submitted: Jul. 14, 2025
Accepted: Dec. 22, 2025
Published online: Feb. 22, 2026

Corresponding author
Paweł Lipowski
Department of Urology and Andrology,
Collegium Medicum,
Nicolaus Copernicus University,
9 M. Curie Skłodowskiej St.,
85-094 Bydgoszcz, Poland,
pavelipovsky@gmail.com

Introduction Simple cystectomy (SC) for radiation-induced bladder dysfunction (RIBD) is occasionally performed, yet data regarding perioperative outcomes are limited. This study aimed to compare perioperative complications following SC for RIBD with radical cystectomy (RC) for bladder cancer.

Material and methods We conducted a retrospective single-center analysis of patients who underwent laparoscopic cystectomy with ureterocutaneostomy between 2016 and 2024. Propensity score matching (PSM) was applied separately for cT1–cT2 stage tumors, cT3–cT4 stage tumors, and for SC group vesicoenteric fistula patients. Outcomes were assessed using the Clavien-Dindo (CD) classification at 30 and 90 days.

Results In total, 257 patients were included in the study: 25 SC for RIBD and 232 RC for BC. Prior to matching, SC patients had significantly higher rates of CD grade ≥3 complications at 30 days (44% vs 22.4%, p <0.001), higher reoperation rates (47.8% vs 11.6%, p <0.001), and prolonged hospital stays (15 vs 9 days, p = 0.002). After matching, SC patients continued to demonstrate more severe complications, especially compared to cT1–T2 RC patients (CD ≥3 complications: 47.1% vs 11.8%, p = 0.057; reoperations: 56.2% vs 5.9%, p = 0.002). In patients with vesicoenteric fistula after matching, CD complication rates at 30 days did not differ significantly between groups (p = 0.130), 90-day complication rates were comparable (p = 0.968), and reoperations occurred significantly more often in the SC group (61.5% vs 6.7%; p = 0.004). Study limitations include the retrospective single-center design, small SC group size and urinary diversion type.

Conclusions Due to high morbidity, non-oncological cystectomy for RIBD should be limited to selected cases and managed in experienced, multidisciplinary centers. Urinary diversion without cystectomy may be a safer alternative.

Key Words: simple cystectomy ‹› radical cystectomy ‹› radiotherapy ‹› vesicoenteric fistula ‹› bladder dysfunction

INTRODUCTION

Radiation-induced bladder dysfunction is a rare complication observed in patients who have undergone pelvic radiotherapy [1]. Although often delayed, long-term complications following pelvic radiotherapy can be severe and commonly necessitate surgical management, accounting for a notable share of emergency urological admissions in high-volume centers [2]. For instance, radiation-induced hemorrhagic cystitis may affect more than 5% of patients at a median of 43.9 months following radiotherapy, with up to half of those cases requir- ing invasive treatment [3]. Fistulas represent one

of the most severe and uncommon toxicities of radiotherapy, occurring in approximately 0.2% of patients undergoing pelvic irradiation due to prostate cancer [4]. It constitutes a strong indication for definitive surgical management [5].

Ionizing radiation initiates a cascade of biological responses including oxidative stress, endothelial dysfunction, and dysregulation of fibroblast activity. This results in persistent inflammation, vascular rarefaction, and excessive extracellular matrix deposition, which collectively impair tissue regeneration and contribute to late-onset complications such as fibrosis, impaired wound healing and tissue fragility [6].

Bladder cancer is managed according to tumor stage and risk stratification. Non-muscle-invasive bladder cancer (NMIBC) is typically treated with transurethral resection followed by intravesical immunotherapy such as Bacillus Calmette–Guérin (BCG) instillations, whereas muscle-invasive bladder cancer (MIBC) often requires radical cystectomy or bladder-sparing approaches [5, 6]. While cystectomy is most commonly performed for oncological indications, it may also be necessary in selected cases of severe non-malignant bladder dysfunction, such as bladder fistulas, perforations, or treatment-resistant hematuria, which is the focus of the present study [9].

There is evidence that cystectomy performed for non-oncological reasons carries significant perioperative risks [10]. Additionally, procedures performed in a previously irradiated surgical field may be associated with significant difficulties in wound healing and infections [9, 10].

Although simple cystectomy due to radiation-induced changes is performed in clinical practice, available data on outcomes and complication risks of this procedure are limited. Most publications focus on radical cystectomies performed for oncological indications or salvage procedures due to bladder cancer recurrence following prior radiotherapy [11–13].

The aim of this study was to compare postoperative complications between patients undergoing simple cystectomy for radiation-induced bladder dysfunction and patients undergoing radical cystectomy for bladder cancer.

MATERIAL AND METHODS

Population

A retrospective analysis was conducted on 257 patients who underwent laparoscopic cystectomy at a single center between 2016 and 2024. The study group included 25 patients who underwent simple cystectomy (SC) due to radiation-induced bladder dysfunction and 232 patients who underwent radical cystectomy (RC) for bladder cancer. In the SC group, radiotherapy had been performed for prior oncological indications such as prostate cancer, cervical cancer, endometrial cancer, or rectal cancer.

All procedures were performed laparoscopically by one experienced surgeon. In the SC group, unilateral right-side ureterocutaneostomy (UCS) was the standard method of urinary diversion; therefore, to ensure consistency and reduce selection bias, only patients from the RC group with UCS urinary diversion were included in the analysis. Patients who underwent salvage cystectomy were excluded from the study. Because many patients were treated in external institutions, radiotherapy documentation was incomplete or unavailable in several cases. Therefore, standardized extraction of RT dose, field, and modality was not feasible.

Study design

The primary aim was to evaluate complications using the Clavien–Dindo (CD) scale at 30 and 90 days postoperatively. Additionally, demographic, clinical, and perioperative parameters, blood transfusions, and length of hospital stay were analyzed.

To minimize differences between groups, propensity score matching was applied. Three separate analyses were conducted. Patients in the SC group were matched with RC patients with clinical tumor stage cT1–cT2 to form the organ-confined disease group (17 vs 17 patients), and separately with RC patients with clinical tumor stage cT3–cT4 for form the advanced disease group (19 vs 19 patients). Additionally, patients with vesicoenteric fistula from the SC group were matched with RC patients regardless of tumor stage.

Statistical analysis

Statistical significance was set at a two-sided alpha level of 0.05. Propensity score matching was conducted using the cardinality matching method to optimize the matched sample size while ensuring covariate balance. The Average Treatment Effect on the Control (ATC) estimand was employed to evaluate the effect of SC compared to RC in patients. Propensity scores were estimated via logistic regression, incorporating ten covariates selected for their clinical relevance as confounders influencing both cystectomy type and postoperative complications: sex, age, BMI, chemotherapy, hypertension, diabetes mellitus, chronic heart failure, chronic kid-

ney disease, American Society of Anesthesiologists (ASA) Physical Status, and Charlson Comorbidity Index (CCI). The rationale and suitability of each covariate are detailed in Suppl. Table A.1. Covari- ate balance was assessed using standardized mean differences (SMD), with SMD <0.1 indicating good balance, and empirical cumulative distribution function (eCDF) metrics.

The matching procedure was performed separately for two RC subgroups based on clinical tumor stag- es: cT1–cT2 (n = 73) and cT3–cT4 (n = 159), com- pared to SC (n = 25).

Continuous variables of matching were summarized using medians and interquartile ranges (IQR) due to non-normal distributions, as assessed by Shap- iro-Wilk tests. Categorical variables were reported as counts and percentages. Descriptive statistics were calculated for the overall matched cohort and separately for SC and RC groups within each tumor stage subgroup (cT1–cT2 and cT3–cT4) to charac- terize baseline, treatment, and outcome variables.

Group differences in clinical characteristics and CD grades were assessed using appropriate statis- tical tests based on variable type and distribution. For continuous variables (e.g., age, BMI, operation time), the Wilcoxon rank-sum test was used due to non- normality. For categorical variables (e.g., sex, CD grades), Pearson's χ^2 test or Fisher's exact test was applied, with the latter used when expected cell counts were less than 5 (e.g., for specific CD grades). Logistic regression with a logit link function was employed to estimate the effect of group (SC vs RC as reference) on CD 3+ incidence at 1-month and 3-month follow- ups. The model effects were re- ported as odds ratios (ORs) with 95% confidence intervals (CIs) and p-values. Model fit was evalu- ated using Tjur's R^2 to measure explained variation in binary outcomes.

The statistical analysis adheres to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for observa- tional studies (von Elm et al. 2007 [16]) and the RECORD (Reporting of Studies Conducted Using Observational Routinely-Collected Data) guidelines for studies using observational data (Benchimol et al. 2015 [17]), ensuring transparency, reproduc- ibility, and methodological rigor.

Analyses were conducted using R (v4.3.3) with pack- ages for matching, regression, balance diagnostics, and visualization (details in Appendix F).

Bioethical standards

The study protocol was approved by the institution- al review board at Nicolas Copernicus University in Torun Collegium Medicum in Bydgoszcz (num- ber approval: KEWL 2/2025).

RESULTS

A total of 257 patients were included in the analysis, comprising 25 patients undergoing simple cystec- tomy (SC) for radiation-induced bladder dysfunc- tion and 232 patients undergoing radical cystec- tomy (RC) for bladder cancer. Demographic and clinical characteristics of both groups are presented in Table 1.

The SC group had a significantly higher proportion of females compared to the RC group (48% vs 22%, p = 0.004). There were no significant differences between groups in terms of age (p = 0.35) or body mass index (BMI). Both groups were comparable regarding comorbidities, including hypertension, diabetes mellitus, chronic kidney disease (defined as eGFR < 60 ml/min calculated using the Cock- croft-Gault formula), and chronic heart failure (diagnosed by a cardiologist).

The Charlson Comorbidity Index was significantly higher in the RC group (median: 5 vs 3; p < 0.001), primarily due to the inclusion of malignancy in the scoring system. Patients in the RC group were also more frequently classified as malnourished accord- ing to the Nutritional Risk Screening (NRS) scale (median: 3 vs 2; p < 0.001). Neoadjuvant chemo- therapy was administered to 37 patients (15.9%) in the RC group.

In the SC group, the median time from completion of radiotherapy to cystectomy was 6 years. A vesi- co-intestinal fistula was diagnosed in 17 patients (68%), 20 patients (75%) had bilateral nephrosto- mies, and 11 patients (44%) had previously under- gone creation of a single-barrel intestinal stoma. The most common indications for radiotherapy were prostate cancer (48%) and cervical cancer (36%). In the remaining patients, radiotherapy was admin- istered due to endometrial cancer and rectal can- cer (8% each). In the SC group, 11 patients (44%) received chemotherapy during primary cancer treatment.

Perioperative outcomes and complications before matching

Operation time, blood loss, and intraoperative blood transfusions did not differ significantly between groups (p = 0.075; p = 0.165; p = 0.175, respec- tively).

The incidence of complications according to the Clavien-Dindo (CD) scale within 30 days reached statistical significance. Patients in the RC group

more frequently experienced mild Grade 1 complications (46.1% vs 12%, p <0.001), whereas severe Grade 3 complications occurred more frequently in the SC group (44% vs 22.4%, p <0.001). No differ- ences were observed in complication rates between 30 and 90 days after cystectomy. However, notably, three patients (12%) from the SC group died within 90 days after surgery compared to eleven patients from RC group (4.7%).

Among patients in the SC group who experienced Clavien-Dindo grade 3 complications, gastrointestinal complications were the most prevalent, reported in 8 cases: adhesive small bowel obstruction (n = 3), enteric fistula or small bowel perforation (n = 6), and small bowel necrosis (n = 1). Addi- tional complications included evisceration (n = 3), pelvic abscess (n = 4), and ureteral necrosis at the site of ureterocutaneostomy (n = 2). Some patients experienced a combination of those complications. In 7 cases, two or more reoperations were required to manage postoperative morbidity.

Patients in the RC group more often required postoperative transfusions of packed red blood cells (77.5% vs 52%, p <0.001). Nonetheless, a higher percentage of SC patients required massive trans- fusions (≥3 units RBC: 36% vs 6.1%, p <0.001). SC patients were more likely to require total paren- teral nutrition (TPN) during hospitalization (36% vs 9.9%, p = 0.001). SC patients more frequently underwent reoperation defined as any subse- quent surgical procedure performed in the operat- ing room to address complications within 30 days (47.8% vs 11.6%, p <0.001). SC group patients more

Table 1. *Demographics and patient characteristics before matching*

Characteristic	SC (N = 25)	RC (N = 232)	p
Demographics			
Sex, n (%) Female Male	12 (48) 13 (52)	51 (22) 181 (78)	0.004
Age, years, median (IQR)	67 (62, 72)	69 (64, 74)	0.354
BMI, kg/m^2, median (IQR)	25.3 (22.7, 29.7)	26.7 (24.2, 30.1)	0.219
Medical history			
CCI, median (IQR)	3.0 (2, 5)	5.0 (4, 6)	< 0.001
Hypertension, n (%)	20 (80)	156 (67.2)	0.192
Diabetes mellitus, n (%)	3 (12)	56 (24,1)	0.170
Heart failure, n (%)	4 (16)	45 (19.4)	0.795
Chronic kidney disease, n (%)	7 (28)	68 (29.3)	0.891
ASA score, median (IQR)	3 (3, 3)	3 (3, 3)	0.531
NRS score, median (IQR)	2 (2, 3)	3 (2.8, 3)	<0.001
Treatment and clinical history			
Chemotherapy, n (%)	11 (44)	37 (15.9)	0.002
Radiotherapy, n (%)	25 (100)	–	–
Time from radiotherapy to cystectomy, years, median (IQR)	6 (3, 16)	–	–
Presence of stoma, n (%)	11 (44)	–	–
Vesicoenteric fistula, n (%)	17 (68)	4 (1.7)	<0.001
Primary diagnosis, n (%) Rectal cancer Cervical cancer Uterine cancer Prostate cancer Bladder cancer	 2 (8) 9 (36) 2 (8) 12 (48) 0 (0)	 0 (0) 0 (0) 0 (0) 0 (0) 232 (100)	<0.001

P-values were calculated using Pearson's χ^2 test, Wilcoxon rank-sum test, or Fisher's exact test, as appropriate.
ASA – American Society of Anesthesiologists; BMI – body mass index; CCI – Charlson Comorbidity Index; NRS – Nutritional Risk Screening

Table 2. *Clavien-Dindo complications and perioperative outcomes before propensity score matching*

Characteristic	SC (N = 25)	RC (N = 232)	p
Surgical details			
Operation time, minutes, median (IQR)	215 (180, 245)	190 (165, 220)	0.075
Blood loss, ml, median (IQR)	220 (100, 300)	250 (150, 350)	0.165
Intraoperative RBC transfusion (%)	0(0	17(7.3)	0.175
Postoperative outcomes			
Postoperative red blood cell transfusion, units, n (%)[b] 0 1 2 ≥3	 13 (52) 2 (8) 1 (4) 9 (36)	 179 (77.5) 10 (4.3) 28 (12.1) 14 (6.1)	<0.001
TPN, n (%)	9 (36)	23 (9.9)	0.001
Reoperation, n (%)	11 (47.8)	27 (11.6)	<0.001
Intensive care unit admission, n (%)	7 (30.4)	10 (4.3)	<0.001
Length of hospital stay, days, median (IQR)	15 (9, 27)	9 (8, 13)	0.002
Clavien-Dindo complications at 30 days, n (%) Grade 1 Grade 2 Grade 3 Grade 4	 3 (12) 5 (20) 11 (44) 0 (0)	 107 (46.1) 60 (25.9) 52 (22.4) 6 (2.6)	<0.001
Clavien-Dindo complications at 90 days, n (%) Grade 1 Grade 2 Grade 3 Grade 4 Grade 5	 3 (12) 2 (8) 2 (8) 0 (0) 3 (12)	 42 (18.1) 60 (25.9) 24 (10.3) 1 (0.4) (4.7)	0.119

p-values were calculated using Pearson's χ^2 test, the Wilcoxon rank-sum test, or Fisher's exact test, as appropriate.
RBC – red blood cell; TPN – total parenteral nutrition

often required admission to the Intensive Care Unit (30.4% vs 4.3%, p <0.001). Hospital length of stay was significantly longer in the SC group (median: 15 days vs 9 days, p = 0.002). A detailed comparison of perioperative outcomes and complication rates between SC and RC groups is presented in Table 2. Between 90 and 180 days of follow-up in the RC group, no new complications were observed in 86% of patients. Clavien–Dindo grade II complications occurred in 8.4% of cases, and no grade III or IV events were recorded. Ten patients died during this period (4.3%). In the SC group, no new complica- tions were observed in 57.9% of patients. Three pa- tients experienced grade II complications (13.6%), and two patients experienced grade III compli- cations (9%). One patient died between 90 and 180 days of follow-up.

Table 3. *Perioperative outcomes and Clavien-Dindo complications after propensity score matching (SC vs RC, cT1–cT2 cohort)*

Characteristic	SC (N = 17)	RC (N = 17)	p
Surgical details			
Operation time, median (IQR), minutes	220 (180, 245)	180 (170, 220)	0.105
Blood loss, median (IQR), ml	250 (100, 300)	200 (150, 350)	0.626
Intraoperative RBC transfusion, n (%)	0(0)	3(18.6)	0.227
Postoperative outcomes			
Postoperative RBC transfusion, n (%)			0.020
0 units	8 (47.1)	15 (88.2)	0.026
1 unit	1 (5.9)	1 (5.9)	1.000
2 units	1 (5.9)	0 (0)	1.000
≥3 units	7 (41.2)	1 (5.9)	0.039
TPN, n (%)	7 (41.2)	1 (5.9)	0.039
Reoperation, n (%)	9 (56.2)	1 (5.9)	0.002
Intensive care unit admission, n (%)	5 (33.3)	1 (5.9)	0.076
Length of hospital stay, median (IQR), days	18 (12, 33)	8.0 (7, 9)	<0.001
Clavien-Dindo complications at 30 days, n (%)			<0.001
Grade 1	0 (0,0)	9 (52,9)	0.001
Grade 2	4 (23.5)	6 (35.3)	0.708
Grade 3	8 (47.1)	2 (11.8)	0.057
Clavien-Dindo complications at 90 days, n (%)			
Grade 1	2 (11.8)	3 (17.6)	0.805
Grade 2	2 (11.8)	2 (11.8)	
Grade 3	2 (11.8)	2 (11.8)	
Grade 5	2 (11.8)	0 (0)	

p-values were calculated using Pearson's χ^2 test, the Wilcoxon rank-sum test, or Fisher's exact test, as appropriate.
RBC – red blood cell; TPN – total parenteral nutrition

Outcomes after propensity score matching for cT1–cT2 tumors

Cardinality matching resulted in 17 matched pairs. The groups were well balanced in all clinical vari- ables (SMD <0.05). Suppl. Table B1 and Suppl. Figure B1 in the Supplementary Materials section summarize balance before and after matching.
The primary outcome, Clavien-Dindo grades, re- vealed significant differences in postoperative complication severity between SC and RC patients at 30 days (p <0.001). Patients from the SC group more often experienced severe Grade 3 compli- cations (47.1% vs 11.8%, p = 0.057). Differences in complications at 90 days were not statistically significant (p = 0.805).
Patients from the SC group more frequently re- quired reoperation (56.2% vs 5.9%, p = 0.002) and more commonly received total parenteral nutri- tion (TPN) (41.2% vs 5.9%, p = 0.039). RC patients more frequently required packed red blood cell transfusions (88.2% vs 44.1%, p = 0.026), although SC patients received massive transfusions (≥3 units RBC) more frequently (41.2% vs 5.9%, p = 0.039). Patients in the SC group required significantly lon- ger hospitalization (18 days vs 8 days, p <0.001). Detailed data are presented in Table 3. Figure 1 illustrates transitions in Clavien-Dindo categories (0–5) at 1-month and 3-month follow-ups.

Outcomes after propensity score matching for cT3–cT4 tumors

Cardinality matching resulted in 19 matched pairs. The groups were well balanced for all clinical vari- ables (SMD <0.05). Suppl. Table C1 and Suppl. Figure C1 in the Supplementary Materials section summarize the balance before and after matching. No statistically significant differences in complica-

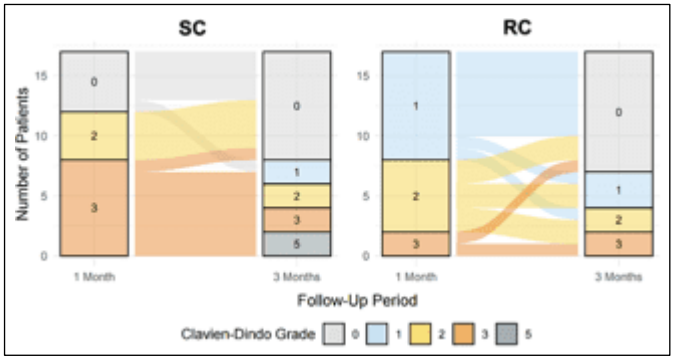


Figure 1. *Transitions in Clavien-Dindo categories (0–5) at 1-month and 3-month follow-ups in SC and RC patients (cT1–cT2) after propensity score matching.*

tions between groups were noted at either 30 days (p = 0.06) or 90 days (p = 0.773) postoperatively.
However, operation time was significantly longer in the SC group (220 min vs 180 min, p = 0.039). Patients in the SC group underwent reopera- tion more frequently (50% vs 10.5%, p = 0.009), and hospital length of stay was significantly lon- ger (17 days vs 8 days, p = 0.013). There were no statistically significant differences regarding the use of TPN (p = 0.141) or blood transfusions (p = 0.592). Detailed data are presented in Table 4. Figure 2 illustrates transitions in Clavien-Dindo categories (0–5) at 1-month and 3-month follow- ups.

Table 4. *Perioperative outcomes and Clavien-Dindo compli- cations after propensity score matching (SC vs RC, cT3–cT4 cohort)*

Characteristic	SC (N = 19)	RC (N = 19)	p
Surgical details			
Operation time, median (IQR), minutes	220 (182.5, 242.5)	180 (167.5, 190)	0.039
Blood loss, median (IQR), ml	250 (125, 300)	200 (150, 275)	0.667
Intraoperative RBC transfusion, n (%)	0(0)	4(21.1)	0.105
Postoperative outcomes			
Postoperative RBC transfusion, n (%)			0.203
0 units	10 (52.6)	13 (68.4)	0.508
1 unit	1 (5.3)	1 (5.3)	1.000
2 units	1 (5.3)	3 (15.8)	0.340
≥3 units	7 (36.8)	2 (10.5)	0055
TPN, n (%)	7 (36.8)	3 (15.8)	0.141
Reoperation, n (%)	9 (50.0)	2 (10.5)	0.009
Intensive care unit admission, n (%)	5 (29.4)	1 (5.3)	0.081
Length of hospital stay, median (IQR), days	17 (11, 28)	8 (8, 11)	0.013
Postoperative outcomes			
Clavien-Dindo grade at 30 days, n (%)			
1	2 (10.5)	8 (42.1)	0.060
2	4 (21.1)	5 (26.3)	
3	8 (42.1)	4 (21.1)	
4	0 (0)	1 (5.3)	
Clavien-Dindo grade at 90 days, n (%)			
1	2 (10.5)	4 (21.1)	0.773
2	2 (10.5)	3 (15.8)	
3	2 (10.5)	2 (10.5)	
5	2 (10.5)	3 (15.8)	

p-values were calculated using Pearson's χ^2 test, the Wilcoxon rank-sum test, or Fisher's exact test, as appropriate.
RBC – red blood cell; TPN – total parenteral nutrition

Outcomes after propensity score matching for patients with vesicoenteric fistula

Cardinality matching resulted in 15 matched pairs. The groups were well balanced in all clinical vari- ables (SMD range: -0.04 to 0.01). Suppl. Table D1 and Suppl. Figure D1 in the Supplementary Mate- rials section summarize balance before and after matching.
The primary outcome, Clavien-Dindo grades at 30 days, showed no significant overall differ- ence (p = 0.130). However, the SC group had a higher proportion of Grade 3 complications (53.3% vs 40.0%). Differences in complications at 90 days were not statistically significant (p = 0.968).
Reoperation rates were significantly higher in the SC group (61.5% vs 6.7%; p = 0.004), and intensive care unit (ICU) admission rates were higher but not significantly (30.8% vs 6.7%; p = 0.153). Total parenteral nutrition (TPN) use was higher in the SC group (40.0% vs 13.3%; p = 0.215), though not statistically significant. Post- operative RBC transfusion rates were significantly higher in the SC group (60% vs 20% p = 0.027). The median length of hospital stay was longer in the SC group (18.0 days vs 10.0 days), though

this difference was not significant (p = 0.244).

DISCUSSION

Radical cystectomy remains the gold standard of muscle invasive bladder cancer treatment. De- spite the development of minimally invasive tech- niques (laparoscopic, robotic-assisted), RC is as- sociated with many complications (18). The most common complications were gastrointestinal com- plications (20%), infectious complications (17%),

and ileus (14%). The majority of complications oc- curring were Clavien-Dindo I–II (45%) [19].

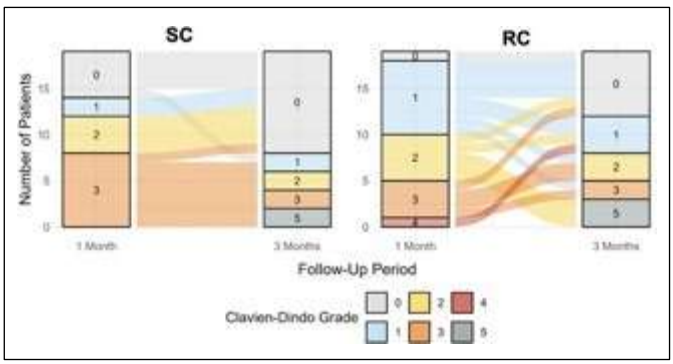


Figure 2. *Transitions in Clavien-Dindo categories (0–5) at 1-month and 3-month follow-ups in SC and RC patients (cT3–cT4) after propensity score matching.*

Non-surgical therapies remain the first-line management for radiation-induced bladder dysfunction (RIBD), particularly in cases of chronic radiation cystitis. Available interventions such as bladder ir- rigation, intravesical instillations, hyperbaric oxy- gen therapy, and arterial embolization have demon- strated varying degrees of efficacy and safety [20]. However, when conservative measures fail, surgical intervention in the form of simple cystectomy (SC) may be required.

The results of this study demonstrate that sim- ple cystectomy performed for radiation-induced bladder dysfunction is associated with a higher risk of severe postoperative complications within 30 days compared to radical cystectomy performed for bladder cancer. This observation is likely at- tributable to the profound tissue damage caused by prior radiotherapy – namely fibrosis, vascular rarefaction, and impaired regenerative capacity [6]. Patients in the SC group more frequently required reoperation and experienced longer hospital stays.

Table 5. *Perioperative outcomes and Clavien-Dindo complications after propensity score matching for patients with viesocenteric fistula*

Characteristic	SC (N = 15)	RC (N = 15)	p[a]
Intraoperative parameters			
Operation time, median (IQR), minutes	230 (200, 250)	185 (165, 195)	0.017
Blood loss, median (IQR), ml	200 (100, 300)	200 (100, 300)	0.949
Intraoperative RBC transfusion, n (%)	0 (0%)	4 (27.7%)	0.100
Postoperative outcomes			
Postoperative RBC transfusion, units	9 (60%)	3 (20%)	0.027
TPN, n (%)	6 (40%)	2 (13.3%)	0.215
Reoperation, n (%)	8 (61.5%)	1 (6.7%)	0.004
Intensive care unit admission, n (%)	4 (30.8%)	1 (6.7%)	0.153
Length of hospital stay, days	18 (8, 33)	10 (8, 17)	0.244
Clavien-Dindo grade at 30 days, n (%)			
1	1 (6.7%)	6 (40%)	0.130
2	4 (26.7%)	1 (6.7%)	
3	8 (53.3%)	6 (40%)	
4	0 (0.0%)	1 (6.7%)	
Clavien-Dindo grade at 90 days, n (%)			
1	2 (13.3%)	2 (13.3%)	0.968
2	2 (13.3%)	4 (26.7%)	
3	2 (13.3%)	2 (13.3%)	
5	1 (6.7%)	1 (6.7%)	

[a] p-values were calculated using Pearson's chi-squared test or Fisher's exact test for categorical variables and the Wilcoxon rank-sum test for continuous variables. RBC – red blood cell; TPN – total parenteral nutrition

This difference remained evident after apply- ing propensity score matching, particularly when compared with patients diagnosed with cT1–cT2 bladder cancer. Although the difference in Cla- vien-Dindo grade ≥3 complications for this group did not reach statistical significance ($p = 0.057$), the markedly higher reoperation rate in the SC group ($p = 0.002$) suggests that the lack of sig- nificance was likely due to the limited sample size rather than the absence of a true clinical difference. The vesicoenteric fistula subgroup showed similar 30- and 90-day Clavien-Dindo distributions and markedly higher reoperation rates ($p = 0.0004$).

Available literature presents conflicting findings; however, direct comparisons with our results are limited due to differences in study populations.

Ramani et al. [14] did not observe differences in complication rates between patients undergoing radical cystectomy and those undergoing salvage cystectomy after radiotherapy. However, all pa- tients in that study underwent surgery for oncologi- cal indications. Moreover, the median time from ra- diotherapy to cystectomy was significantly shorter (483 days), which may have influenced the degree of tissue fibrosis and healing capacity.

Nguyen et al. [21] analyzed patients who under- went radical cystectomy for bladder cancer follow- ing prior radiotherapy. The median interval be- tween radiotherapy and cystectomy was 8.6 years. This study found no difference in 30-day complica- tions compared to patients who had not received ra- diotherapy. As in the previous study, it is important to note that the indication for surgery was oncologi- cal, rather than functional damage caused by radia- tion, which may imply a lesser degree of radiation-related tissue injury in that population.

In a large ACS-NSQIP database analysis using propensity score matching, Titus et al. [13] found that patients with a history of radiotherapy undergoing radical cystectomy had an increased risk of intraoperative rectal injury, 30-day readmissions, and infectious complications. While this study included over 5,000 patients and is methodologically comparable, the procedures were likewise performed for oncolog- ical rather than functional indications.

Similar observations have also been confirmed in other surgical disciplines. For example, Onoda et al. [11] found that radiation-induced changes increased complication rates and impaired wound healing in head and neck reconstructive procedures, while Potkrajcic et al. [12] reported that prior radio- therapy was associated with higher rates of wound infections after soft tissue carcinoma resection.

According to meta-analytic data, surgery for vesicoenteric fistulas is associated with a 22.2% complication

rate and a 4.9% mortality rate [22]. However, evi- dence on bladder resection for radiation-induced fistulas remains very limited. Some reports suggest that prior radiotherapy does not significantly affect surgical outcomes of cystectomy with urinary diver- sion compared to urinary diversion alone in a high- volume center [23]. It should be noted, however, that data on reoperation rates in this subgroup may be biased due to the small sample sizes of available cohorts.

Our cohort did not include patients treated with urinary diversion alone, as this procedure was not performed in our center during the study pe- riod. Therefore, direct comparison was not feasible. However, published data suggest that diversion alone may carry lower morbidity in selected benign conditions, which supports considering it as an al- ternative in RIBD [23].

Our findings suggest that patients with radiation-induced bladder dysfunction should be carefully se- lected for non-oncological cystectomy. They should be explicitly informed about the high risk of postop- erative complications. If surgery is deemed neces- sary, it should be performed in a high-volume center with access to multidisciplinary support, including an experienced clinical nutrition team. Whenever feasible, isolated urinary diversion without the ab- lative component should be considered.

It must be acknowledged that this is a single-center, retrospective study, which introduces the potential for systematic bias. Secondly, the small number of patients in the SC group, further reduced by propensity score matching, raises the risk of type II error. Consequently, some clinically relevant differences may not have reached statistical sig- nificance. A power calculation was not performed because the study included all available SC and RIBD patients treated during the study period. De- tailed radiotherapy parameters (dose, field, modal- ity) were inconsistently documented in historical records and therefore could not be analyzed. Fur- thermore, we included only patients undergoing a single type of urinary diversion and a single sur- gical approach, which limits the generalizability of our findings.

CONCLUSIONS

Despite its limitations, this study clearly demon- strates that simple cystectomy performed for radia- tion-induced bladder dysfunction carries a substan- tial risk of perioperative complications, including severe adverse events. This risk is either greater than or at least comparable to that observed in pa- tients undergoing radical cystectomy for bladder cancer. The findings highlight the need for careful patient selection and comprehensive multidisci- plinary perioperative care. Multicenter studies are needed to generate higher-quality evidence.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

FUNDING

This research received no external funding.

ETHICS APPROVAL STATEMENT

The study protocol was approved by the institutional review board at Nicolas Copernicus University in Torun Collegium Medicum in By- dgoszcz (number approval: KEWL 2/2025).

SUPPLEMENTARY MATERIALS

Appendix A. List and justification of covariate selection for matching procedure

Suppl. Table A.1. *Rationale and suitability of covariates for matching*

Covariate	Rationale	Suitability
Sex	Influences surgical choice (e.g., anatomical differences) and complication risk (e.g., infection)	Appropriate; baseline demographic confounder
Age	Affects surgical candidacy and complication risk due to physiological reserve	Highly appropriate; strong confounder
BMI	Impacts surgical complexity and complication risk (e.g., wound infections)	Appropriate; surgical risk indicator
Chemotherapy	Pre-treatment history affects tissue healing and complication risk	Appropriate; pre-exposure oncologic factor
HT	Common comorbidity increasing cardiovascular and surgical risks	Appropriate; baseline comorbidity
DM	Increases infection and healing complications	Appropriate; baseline comorbidity
HF	Elevates perioperative morbidity and mortality risk	Appropriate; baseline comorbidity
CKD	Common in urological patients, affecting surgical outcomes	Appropriate; baseline comorbidity
ASA	Standardized measure of preoperative health, predicting complications	Highly appropriate; surgical risk indicator
CCI	Quantifies comorbidity burden, influencing surgical choice and outcomes	Highly appropriate; comprehensive confounder

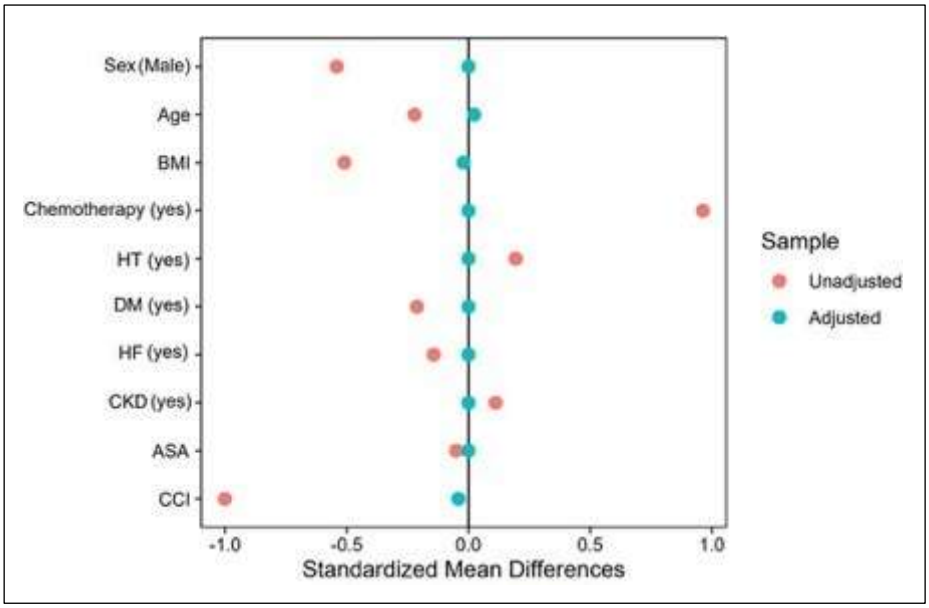
ASA – American Society of Anesthesiologists; BMI – body mass index; CCI – Charlson Comorbidity Index; CKD – chronic kidney disease; DM – diabetes mellitus; HF – heart failure; HT – hypertension

Appendix B. Results of propensity score matching procedure for SC and RC in patients with clinical stages cT1–cT2

Suppl. Table B.1. *Balance of covariates before and after cardinality matching for SC vs RC (cT1–cT2)*

Covariate	Type	Means Treated (SC)	Means Control (RC)	SMD (Unmatched)	SMD (Matched)	eCDF Max (Matched)
Sex (Female)	Binary	0.48	0.27	0.54	0	0
Sex (Male)	Binary	0.52	0.75	−0.54	0	0
Age	Continuous	67.52	69.21	−0.22	0.02	0.18
BMI	Continuous	25.71	28.12	−0.51	−0.02	0.18
Chemotherapy (yes)	Binary	0.44	0.12	0.96	0	0
Chemotherapy (no)	Binary	0.56	0.88	−0.96	0	0
HT (yes)	Binary	0.80	0.71	0.19	0	0
HT (no)	Binary	0.20	0.29	−0.19	0	0
DM (yes)	Binary	0.12	0.22	−0.21	0	0
DM (no)	Binary	0.88	0.79	0.21	0	0
HF (yes)	Binary	0.16	0.22	−0.14	0	0
HF (no)	Binary	0.84	0.78	0.14	0	0
CKD (yes)	Binary	0.28	0.23	0.11	0	0
CKD (no)	Binary	0.72	0.77	−0.11	0	0
ASA	Continuous	2.76	2.78	−0.05	0	0
CCI	Continuous	3.64	5.07	−1.00	−0.04	0.18

ASA – American Society of Anesthesiologists; BMI – body mass index; CCI – Charlson Comorbidity Index; CKD – chronic kidney disease; DM – diabetes mellitus; HF – heart failure; HT – hypertension



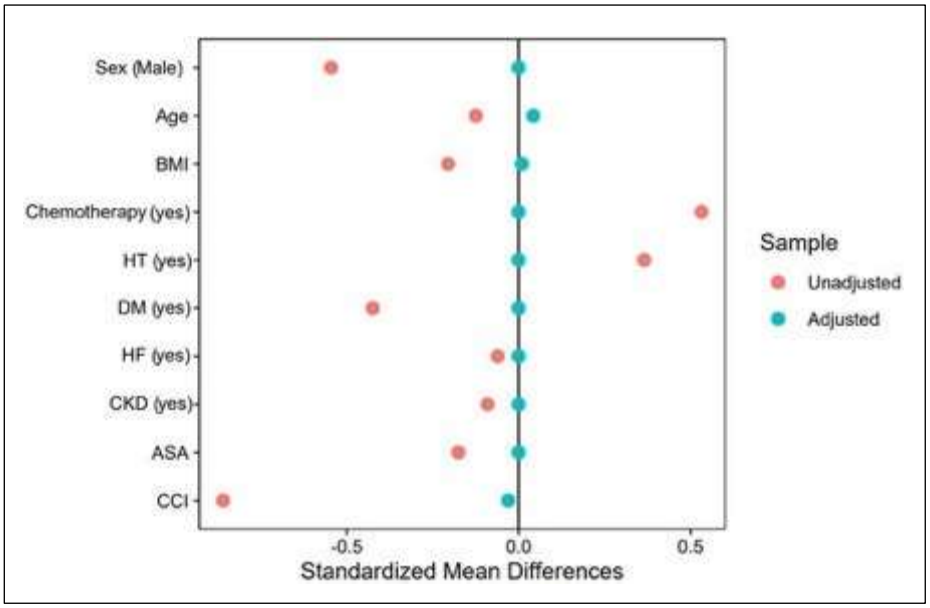
Suppl. Figure B.1. *Covariate balance for unadjusted (SC, n = 25 vs RC, n = 73) and adjusted (SC, n = 17 vs RC, n = 17) samples.*

Appendix C. Results of propensity score matching procedure for SC and RC in patients with clinical stages cT3–cT4

Suppl. Table C.1. *Balance of covariates before and after cardinality matching for SC vs RC (cT3–cT4)*

Covariate	Type	Means Treated (SC)	Means Control (RC)	SMD (Unmatched)	SMD (Matched)	eCDF Max (Matched)
Sex (Female)	Binary	0.48	0.21	0.55	0	0
Sex (Male)	Binary	0.52	0.79	–0.55	0	0
Age	Continuous	67.52	68.44	–0.12	0.04	0.26
BMI	Continuous	25.71	26.65	–0.21	0.01	0.16
Chemotherapy (yes)	Binary	0.44	0.18	0.53	0	0
Chemotherapy (no)	Binary	0.56	0.82	–0.53	0	0
HT (yes)	Binary	0.8	0.65	0.36	0	0
HT (no)	Binary	0.2	0.35	–0.36	0	0
DM (yes)	Binary	0.12	0.26	–0.42	0	0
DM (no)	Binary	0.88	0.74	0.42	0	0
HF (yes)	Binary	0.16	0.18	–0.06	0	0
HF (no)	Binary	0.84	0.82	0.06	0	0
CKD (yes)	Binary	0.28	0.32	–0.09	0	0
CKD (no)	Binary	0.72	0.68	0.09	0	0
ASA	Continuous	2.76	2.84	–0.18	0	0
CCI	Continuous	3.64	5.13	–0.86	–0.03	0.16

ASA – American Society of Anesthesiologists; BMI – body mass index; CCI – Charlson Comorbidity Index; CKD – chronic kidney disease; DM – diabetes mellitus; HF – heart failure; HT – hypertension



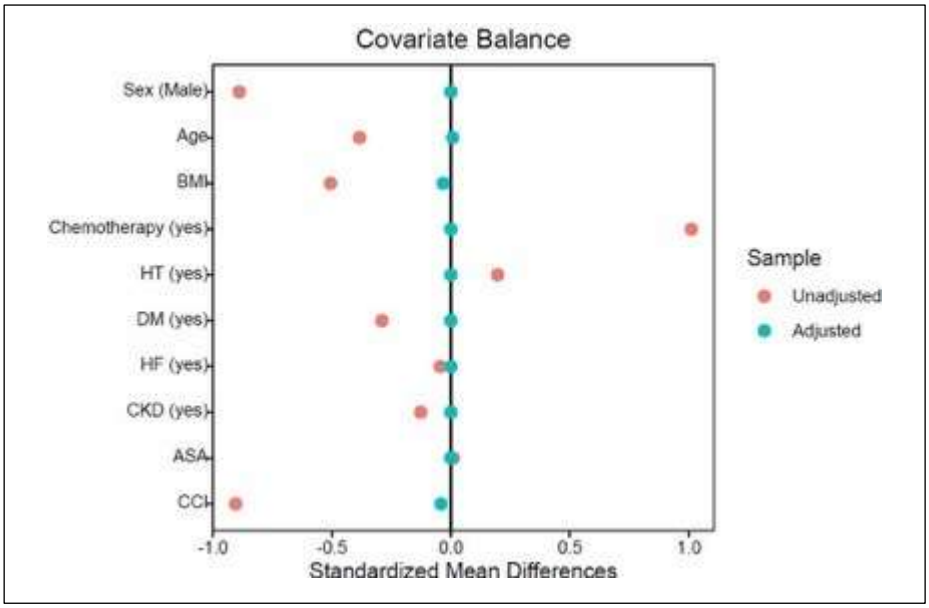
Suppl. Figure C.1. *Covariate balance for unadjusted (SC, n = 25 vs RC, n = 140) and adjusted (SC, n = 19 vs RC, n = 19) samples.*

Appendix D. Results of propensity score matching procedure for SC group patients with vesico-enteric fistula and RC group

Suppl. Table D1. Covariate balance in unmatched and matched cohorts

Covariate	Unmatched						Matched						
	Means Treated	Means Control	SMD	Var. Ratio	eCDF Mean	eCDF Max	Means Treated	Means Control	SMD	Var. Ratio	eCDF Mean	eCDF Max	Adj. Diff.
Sex (male)	0.41	0.78	−0.89	.	0.37	0.37	0.47	0.47	0.00	.	0.00	0.00	0.00
Age	65.35	68.68	−0.38	0.55	0.09	0.26	66.13	66.07	0.01	0.28	0.09	0.20	0.01
BMI	24.84	27.11	−0.51	1.19	0.13	0.25	24.91	25.06	−0.03	1.97	0.12	0.27	−0.03
Chemotherapy (yes)	0.53	0.16	1.01	.	0.37	0.37	0.47	0.47	0.00	.	0.00	0.00	0.00
HT (yes)	0.76	0.67	0.20	.	0.09	0.09	0.80	0.80	0.00	.	0.00	0.00	0.00
DM (yes)	0.12	0.24	−0.29	.	0.12	0.12	0.13	0.13	0.00	.	0.00	0.00	0.00
HF (yes)	0.18	0.19	−0.04	.	0.02	0.02	0.20	0.20	0.00	.	0.00	0.00	0.00
CKD (yes)	0.24	0.29	−0.13	.	0.06	0.06	0.27	0.27	0.00	.	0.00	0.00	0.00
ASA	2.82	2.82	0.01	0.84	0.01	0.02	2.80	2.80	0.00	1.00	0.00	0.00	0.00
CCI	3.65	5.11	−0.90	1.39	0.15	0.39	3.93	4.00	−0.04	2.13	0.06	0.13	−0.04

Adj. Diff. – adjusted difference (Treated – Control); ASA – American Society of Anesthesiologists; BMI – body mass index; CCI – Charlson Comorbidity Index; CKD – chronic kidney disease; DM – diabetes mellitus; eCDF – empirical cumulative distribution function (mean and maximum differences; lower values indicate better distributional balance); HF – heart failure; HT – hypertension; SMD – standardized mean difference (values below 0.1 indicate adequate balance); Var. Ratio – variance ratio (values close to 1 indicate similar variability)



Suppl. Figure D1. *Covariate balance for unadjusted (SC, n = 17 vs RC, n = 232, red color) and adjusted (SC, n = 15 vs RC, n = 15, blue color) samples.*

Appendix F. Statistical software and packages used

Analyses were conducted using the R statistical programming language (version 4.3.3) on Windows 11 Pro 64 (build 26100), using the packages *ggalluvial* (version 0.12.5), *rio* (version 1.2.1), *cobalt* (version 4.5.5), *MatchIt* (version 4.5.5), *sjPlot* (version 2.8.15), *report* (version 0.5.8), *gtsummary* (version 1.7.2), *glmtoolbox* (version 0.1.12), *ggplot2* (version 3.5.0), *Rglpk* (version 0.6.5.1), *Rsymphony* (version 0.1.33), and *dplyr* (version 1.1.4).

References

1. Spratt DE, Pei X, Yamada J, Kollmeier MA, Cox B, Zelefsky MJ. Long-term survival and toxicity in patients treated with high-dose intensity modulated radiation therapy for localized prostate cancer. Int J Radiat Oncol Biol Phys. 2013; 85: 686-692.
2. Ma JL, Hennessey DB, Newell BP, Bolton DM, Lawrentschuk N. Radiotherapy-related complications presenting to a urology department: a more common problem than previously thought? BJU Int. 2018; 121 Suppl 3: 28-32.
3. Sanguedolce F, Sancho Pardo G, Mercadé Sanchez A, et al. Radiation- induced haemorrhagic cystitis after prostate cancer radiotherapy: factors associated to hospitalization and treatment strategies. Prostate Int. 2021; 9: 48-53.
4. Sadighian M, Hakam N, Amend G, et al. Radiation-induced Fistulas in Patients With Prior Pelvic Radiotherapy for Prostate Cancer: A Systematic Review and Meta-analysis. Urology. 2023; 176: 121-126.
5. Chrouser KL, Leibovich BC, Sweat SD, et al. Urinary fistulas following external radiation or permanent brachytherapy for the treatment of prostate cancer. J Urol. 2005; 173: 1953-1957.
6. Dormand EL, Banwell PE, Goodacre TEE. Radiotherapy and wound healing. Int Wound J. 2005; 2: 112-127.
7. Bursiewicz W, Złotkiewicz M, Krajewski W, et al. Long-term efficacy and safety of intravesical Bacillus Calmette-Guerin Moreau Polish substrain in the treatment of non-muscle invasive bladder cancer. Cent European J Urol. 2024; 77: 196-202.
8. Zaytoun O, Tillu N, Kolanukuduru K, et al. Thulium laser en bloc resection is a safe and efficacious alternative to conventional bipolar transurethral resection of bladder tumors. Cent European J Urol. 2024; 77: 466-471.
9. Mendenhall WM, Henderson RH, Costa JA, et al. Hemorrhagic radiation cystitis. Am J Clin Oncol. 2015; 38: 331-336.
10. Chong JT, Dolat MET, Klausner AP, Dragoescu E, Hampton LJ. The role of cystectomy for non-malignant bladder conditions: A review. Can J Urol. 2014; 21: 7433-7441.
11. Onoda S, Kimata Y, Sugiyama N, Onoda T, Mizukawa N. Effects of radiation therapy on postoperative complications and adverse events in patients with head and neck reconstruction with flaps. Microsurgery. 2014; 34: 516-521.
12. Potkrajcic V, Kolbenschlag J, Sachsenmaier S, et al. Postoperative complications and oncologic outcomes after multimodal therapy of localized high risk soft tissue sarcoma. Radiation Oncology. 2022; 17: 1-11.
13. Titus RS, Xu J, Mundra V, et al. IP24-23 The association between prior pelvic radiotherapy for cancer and surgical

outcomes in patients undergoing radical cystectomy for bladder cancer: An analysis of national surgical quality improvement program targeted cystectomy database. Urol Oncol. 2026; 44: 62.e9-62.e16.

14. Ramani VAC, Maddineni SB, Grey BR, Clarke NW. Differential complication rates following radical cystectomy in the irradiated and nonirradiated pelvis. Eur Urol. 2010; 57: 1058-1063.

15. Murthy PB, Lone Z, Corrigan D, et al. Survival outcomes following radical cystectomy in patients with prior pelvic radiation for prostate cancer: A matched cohort analysis. Urol Oncol. 2022; 40: 10.e13-10.e19.

16. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008; 61: 344-349.

17. Benchimol EI, Smeeth L, Guttmann A, et al. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement. PLoS Med. 2015; 12: e1001885.

18. Rahota RG, Beauval JB, Gautier JR, et al. Impact of outcomes and costs for implementation of robotic radical cystectomy with full intracorporeal urinary diversion. Cent European J Urol. 2023; 76: 305-310.

19. Katsimperis S, Tzelves L, Tandogdu Z, et al. Complications After Radical Cystectomy: A Systematic Review and Meta-analysis of Randomized Controlled Trials with a Meta-regression Analysis. Eur Urol Focus. 2023; 9: 920-929.

20. Datseris N, Gkazis T, Nikas S, Memmos D, Zoumpanioti E, Sountoulides P. Safety and efficacy of non-surgical treatments for chronic post-radiation cystitis: a systematic review. Cent European J Urol. 2024; 77: 472-482.

21. Nguyen DP, Al Hussein Al Awamlh B, Faltas BM, et al. Radical Cystectomy for Bladder Cancer in Patients With and Without a History of Pelvic Irradiation: Survival Outcomes and Diversion-related Complications. Urology. 2015; 86: 99-106.

22. Granieri S, Sessa F, Bonomi A, et al. Indications and outcomes of enterovesical and colovesical fistulas: systematic review of the literature and meta-analysis of prevalence. BMC Surg. 2021; 21: 265.

23. Vetterlein MW, Buhné MJ, Yu H, et al. Urinary Diversion With or Without Concomitant Cystectomy for Benign Conditions: A Comparative Morbidity Assessment According to the Updated European Association of Urology Guidelines on Reporting and Grading of Complications. Eur Urol Focus. 2022; 8: 1831-1839.

8. Nota biograficzna i wykaz osiągnięć doktoranta

Data i miejsce urodzenia: 12.07.1995 miasto Kercz, Krym, Ukraina

Wykształcenie i przebieg pracy zawodowej:

2012-2018 – Studia za Wydziale Lekarskim Collegium Medicum Uniwersytetu Jagiellońskiego w Krakowie.

2018-2019 – Staż podyplomowy w Szpitalu Specjalistycznym im Stefana Żeromskiego w Krakowie.

2020-2026 – Specjalizacja w dziedzinie urologii w Klinice Urologii Ogólnej i Onkologicznej Szpitala Uniwersyteckiego nr. 1 im dr A. Jurasza w Bydgoszczy.

Członkostwa:

- Członek Polskiego Towarzystwa Urologicznego (PTU)
- Członek Europejskiego Towarzystwa Urologicznego (EAU)

8.1 Publikacje

Łącznie 8 publikacji w czasopismach międzynarodowych
Sumaryczny IF = 29,6
Sumaryczne punkty MEiN = 800

1. P. Lipowski *et al.*, "Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review," Cancers (Basel), vol. 17, no. 11, Jun. 2025, doi: 10.3390/CANCERS17111746.
IF = 4,4 Punkty MNiE = 140

2. P. Lipowski *et al.*, "Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy?" Cancers (Basel), vol. 17, no. 1, Jan. 2024, doi: 10.3390/CANCERS17010102.
IF = 4,4 Punkty MNiE = 140

3. F. Kowalski *et al.*, "Endourological treatment of ureteral strictures with the use of self-expanding stents: is it possible to completely cure the stricture endoscopically? A report on the experience with implantation of 35 stents with a two-year follow-up period; a retrospective study," World J Urol, vol. 43, no. 1, Dec. 2025, doi: 10.1007/S00345-025-05574-9.
IF = 2,9; Punkty MNiE = 100

4. A. Ostrowski *et al.*, "Current thromboprophylaxis in urological cancer patients during COVID-19 pandemic," Cent European J Urol, vol. 75, no. 2, pp. 128–134, 2022, doi: 10.5173/CEJU.2022.0047.
IF = 1,9; Punkty MNiE = 70

5. Lipowski P *et al.*, "Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026; doi: 10.5173/ceju.2025.0163
IF = 1,9; Punkty MNiE = 70

6. Mazurczyk Ł *et al.,* "Urinary incontinence as the first clinical symptom of urinary bladder leiomyosarcoma," Cent European J Urol. 2025 Apr 28;78(2):103–108. doi: 10.5173/ceju.2024.0280.
IF = 1,9; Punty MNiE = 70

7. Settaf-Cherif L *et al.,* "Inflammatory myofibroblastic tumor of the urinary bladder: A rare diagnostic challenge." Cent European J Urol. 2025; doi: 10.5173/ceju.2025.0195
IF = 1,9; MNiE = 70

8. Kowalski, Filip PhD *et al.,* "Determining appropriate indications for the self-expanding, metallic stents in the treatment of ureteral strictures of different etiology – efficiency and safety analysis of 65 stents implantations: a single-center, retrospective cohort study." International Journal of Surgery February 03, 2026.
doi: 10.1097/JS9.0000000000004909
IF 10,3 MNiE = 140

8.2 Doniesienia zjazdowe

1. „Zastosowanie kalkulatorów ryzyka w pierwotnych guzach pęcherza moczowego. Korelacja ryzyka wynikami badań obrazowych oraz ostatecznym wynikiem histopatologicznym.” Paweł Lipowski, Adam Ostrowski, Filip Kowalski, Jan Adamowicz, Kajetan Juszczak, Tomasz Drewa
   52 Kongres Polskiego Towarzystwa Urologicznego 2022r.

2. „Bezpieczeństwo i przeżycie całkowite pacjentów poddanych cystektomii ratującej z powodu nowotworu gruczołu krokowego naciekającego pęcherz moczowy.” Paweł Lipowski, Adam Ostrowski, Michał Czarnogórski, Filip Ryszard Kowalski, Jan Adamowicz, Kajetan Juszczak, Tomasz Drewa
   53 Kongres Polskiego Towarzystwa Urologicznego 2023r.

3. „Feasibility of VIRADS scale in primary bladder cancer - clinical implications and prediction of recurrence and indications for radical cystectomy.” Paweł Lipowski, Adam Ostrowski, Michał Czarnogórski, Filip Kowalski, Jan Adamowicz, Kajetan Juszczak, Zbigniew Serafin, Tomasz Drewa
   53 Kongres Polskiego Towarzystwa Urologicznego 2023r.

4. “Does the intravenous fluid administration matter in the context of the incidence of postoperative complications after radical cystectomy?” Paweł Lipowski, Adam Ostrowski, Filip Ryszard Kowalski, Jan Adamowicz, Tomasz Drewa, Kajetan Juszczak
   54 Kongres Polskiego Towarzystwa Urologicznego 2024r.

5. “Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review.” Paweł Lipowski, Adam Ostrowski, Jan Adamowicz, Filip Kowalski, Tomasz Drewa, Kajetan Juszczak
   55 Kongres Polskiego Towarzystwa Urologicznego 2025r.

6. „Zaawansowany nowotwór urotelialny pęcherza moczowego. Okołooperacyjne postępowanie żywieniowe.” Przypadek Kliniczny. Paweł Lipowski, Tomasz Drewa
   XI Sympozium „Onkologia i Żywienie” Bydgoszcz 2025r.

8.3 Autorstwo w podręcznikach medycznych:

Współautorstwo dla podręcznika „Urologia – ilustrowany podręcznik dla studentów i stażystów” wyd II. 2023r. Wydawnictwo PZWL. Redakcja naukowa: Tomasz Drewa, Kajetan Juszczak.

Łącznie 11 przypadków klinicznych z wariantami odpowiedzi na zadane pytanie oraz omówieniem:

- Zatrzymanie moczu.
- Uchyłek cewki moczowej,
- Dootrzewnowa perforacja pęcherza moczowego,
- Zaotrzewnowa perforacja pęcherza moczowego,
- Tamponada pęcherza moczowego,
- NMIBC. Rak pęcherza moczowego nienaciekający mięśniówki właściwej pęcherza moczowego,
- MIBC. Rak pęcherza moczowego naciekający mięśniówkę właściwą pęcherza moczowego,
- Rak górnych dróg moczowych,
- Rak stercza ograniczony do narządu,
- Rak stercza z przerzutami do układu kostnego,
- Przetoka pęcherzowo-jelitowa.

9. Załączniki

9.1 Zgody komisji Bioetycznej

1. Zgoda Komisji Bioetycznej Nr 2/2025

2. Zgoda Komisji Bioetycznej Nr 55/2025

Uniwersytet Mikołaja Kopernika w Toruniu
Collegium Medicum im L. Rydygiera w Bydgoszczy
KOMISJA ETYKI BADAŃ NAUKOWYCH WYDZIAŁU LEKARSKIEGO
Ul. M. Skłodowskiej-Curie 9, 85-094 Bydgoszcz

KEWL 2/2025

Bydgoszcz, 30.07.2025 r.

Komisja Etyki Badań Naukowych Wydziału Nauk o Zdrowiu przy UMK w Toruniu, Collegium Medicum w Bydgoszczy

na posiedzeniu w dniu 30.07.2025 r. przeanalizowała wniosek, który złożył kierownik badania:

prof. dr hab. n. med. Tomasz Drewa
Katedra Urologii i Andrologii
Collegium Medicum w Bydgoszczy UMK w Toruniu

z zespołem w składzie:

- lek. Paweł Lipowski, prof. dr hab. n. med. Tomasz Drewa FEBU, dr hab. n. med. Kajetan Juszczak, prof. UMK FEBU, dr hab. n. med. Jan Adamowicz, prof. UMK FEBU, dr n. med. Adam Ostrowski FEBU, dr n. med. Filip Kowalski FEBU, lek. Anastazja Zaigrajewa,

w sprawie badania:

„Retrospektywna ocena powikłań pooperacyjnych u pacjentów poddanych cystektomii prostej z powodu popromiennej dysfunkcji pęcherza moczowego w porównaniu do pacjentów poddanych cystectomii radykalnej z powodu nowotworu pęcherza moczowego."

Po zapoznaniu się ze złożonym wnioskiem i w wyniku przeprowadzonej dyskusji oraz głosowania Komisja podjęła:

Uchwałę o pozytywnym zaopiniowaniu wniosku

w sprawie przeprowadzenia badań w zakresie określonym we wniosku pod warunkiem uzyskania zgody osób badanych na przetwarzanie danych osobowych w celach naukowych, a w przypadku braku takiej zgody, analizowania jedynie danych zanonimizowanych, pozbawionych danych personalnych (zgodnie z RODO). Opinia obejmuje tylko dane z dokumentacji uczestników badania z okresu od 01.01.2016 r. do 31.12.2024 r.

Opinia obowiązuje od daty podjęcia uchwały (30.07.2025 r.) do końca 2025 r.

Wydana opinia dotyczy tylko rozpatrywanego wniosku z uwzględnieniem przedstawionego projektu; każda zmiana i modyfikacja wymaga uzyskania odrębnej opinii. Wnioskodawca zobowiązany jest do informowania o wszelkich poprawkach, które mogłyby mieć wpływ na opinię Komisji.

Od niniejszej uchwały podmiot zamierzający przeprowadzić badanie, kierownik placówki, w której badanie ma być przeprowadzone, mogą wnieść odwołanie do Komisji Bioetycznej przy Collegium Medicum im. L. Rydygiera w Bydgoszczy, za pośrednictwem Komisji Etyki Badań Naukowych Wydziału Lekarskiego przy Collegium Medicum im. L. Rydygiera w Bydgoszczy, w terminie 14 dni od daty otrzymania niniejszej Uchwały.

mgr Jacek Swobodziński

Przewodniczący Komisji

Otrzymuje:
prof. dr hab. n. med. Tomasz Drewa
Katedra Urologii i Andrologii
Collegium Medicum w Bydgoszczy UMK w Toruniu

Uniwersytet Mikołaja Kopernika w Toruniu
Collegium Medicum im L. Rydygiera w Bydgoszczy
KOMISJA ETYKI BADAŃ NAUKOWYCH WYDZIAŁU LEKARSKIEGO
Ul. M. Skłodowskiej-Curie 9, 85-094 Bydgoszcz

KEWL 55/2025 Bydgoszcz, 17.12.2025 r.

Komisja Etyki Badań Naukowych Wydziału Nauk o Zdrowiu przy UMK w Toruniu, Collegium Medicum w Bydgoszczy

na posiedzeniu w dniu 17.12.2025 r. przeanalizowała wniosek, który złożył kierownik badania:

prof. dr hab. n. med. Tomasz Drewa
Katedra Urologii i Andrologii
Collegium Medicum w Bydgoszczy UMK w Toruniu

z zespołem w składzie:

- lek. Paweł Lipowski, prof. dr hab. n. med. Tomasz Drewa FEBU, dr hab. n. med. Kajetan Juszczak, prof. UMK FEBU, dr hab. n. med. Jan Adamowicz, prof. UMK FEBU, dr n. med. Adam Ostrowski FEBU, dr n. med. Filip Kowalski FEBU, dr n. med. Jacek Wilamowski FEBU, dr n. med. Patryk Warsiński FEBU

w sprawie badania:

„Retrospektywna ocena powikłań pooperacyjnych w zależności od prowadzonej płynoterapii okołooperacyjnej u pacjentów poddanych laparoskopowej cystektomii radykalnej z powodu nowotworu z pęcherza moczowego."

Po zapoznaniu się ze złożonym wnioskiem i w wyniku przeprowadzonej dyskusji oraz głosowania Komisja podjęła:

Uchwałę o pozytywnym zaopiniowaniu wniosku

w sprawie przeprowadzenia badań w zakresie określonym we wniosku pod warunkiem uzyskania zgody osób badanych na przetwarzanie danych osobowych w celach naukowych, a w przypadku braku takiej zgody, analizowania jedynie danych zanonimizowanych, pozbawionych danych personalnych (zgodnie z RODO). Opinia obejmuje tylko dane z dokumentacji uczestników badania z okresu od 01.01.2018 r. do 31.12.2022 r.

Opinia obowiązuje od daty podjęcia uchwały (17.12.2025 r.) do końca 2026 r.

Wydana opinia dotyczy tylko rozpatrywanego wniosku z uwzględnieniem przedstawionego projektu; każda zmiana i modyfikacja wymaga uzyskania odrębnej opinii. Wnioskodawca zobowiązany jest do informowania o wszelkich poprawkach, które mogłyby mieć wpływ na opinię Komisji.

Od niniejszej uchwały podmiot zamierzający przeprowadzić badanie, kierownik placówki, w której badanie ma być przeprowadzone, mogą wnieść odwołanie do Komisji Bioetycznej przy Collegium Medicum im. L. Rydygiera w Bydgoszczy, za pośrednictwem Komisji Etyki Badań Naukowych Wydziału Lekarskiego przy Collegium Medicum im. L. Rydygiera w Bydgoszczy, w terminie 14 dni od daty otrzymania niniejszej Uchwały.

mgr Jacek Swobodziński
Przewodniczący Komisji

Otrzymuje:
prof. dr hab. n. med. Tomasz Drewa
Katedra Urologii i Andrologii
Collegium Medicum w Bydgoszczy UMK w Toruniu

9.2 Oświadczenia współautorów

Załącznik nr 5 do uchwały Nr 38 Senatu UMK z dnia 26 września 2023 r. w sprawie postępowania o nadanie stopnia doktora na Uniwersytecie Mikołaja Kopernika w Toruniu

Bydgoszcz, dnia 24.01.2026

Lek. Paweł Lipowski

Klinika Urologii Ogólnej i Onkologicznej SU nr.1 im. dr A. Jurasza w Bydgoszczy

Rada Dyscypliny Nauki Medyczne
Uniwersytetu Mikołaja Kopernika
w Toruniu

Oświadczenie o współautorstwie

Niniejszym oświadczam, że:

W pracy Lipowski P, Ostrowski A, Adamowicz J, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy? *Cancers*. 2025; 17(1):102. https://doi.org/10.3390/cancers17010102 mój udział polegał projektowaniu, koncepcji, metodologii i analizie danych, pisaniu artykułu oraz współkoordynacji projektu.

W pracy Lipowski P, Ostrowski A, Adamowicz J, Kowalski F, Drewa T, Juszczak K. Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review. Cancers (Basel). 2025 May 22;17(11):1746. doi:10.3390/cancers17111746 mój udział polegał na koncepcji, metodologii, analizie danych, realizacji badania, pisaniu artykułu i wizualizacji.

W pracy Lipowski P, Ostrowski A, Adamowicz J, Zaigrajewa A, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026; doi: 10.5173/ceju.2025.0163 mój udział polegał na metodologii, koncepcji i planowaniu badania, analizie danych, pisaniu artykułu, oraz wizualizacji.

.....
(podpis)

Załącznik nr 5 do uchwały Nr 38 Senatu UMK z dnia 26 września 2023 r. w sprawie postępowania o nadanie stopnia doktora na Uniwersytecie Mikołaja Kopernika w Toruniu

Bydgoszcz, dnia 25.02.2026

Dr hab. n. med. Kajetan Juszczak, prof. UMK

Katedra Urologii i Andrologii Collegium Medicum im. Ludwika Rydygiera w Bydgoszczy
Uniwersytet Mikołaja Kopernika w Toruniu

Rada Dyscypliny Nauki Medyczne
Uniwersytetu Mikołaja Kopernika
w Toruniu

Oświadczenie o współautorstwie

Niniejszym oświadczam, że:

W pracy Lipowski P, Ostrowski A, Adamowicz J, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy? *Cancers*. 2025; 17(1):102. https://doi.org/10.3390/cancers17010102) mój udział polegał na opracowaniu metodyki, walidacji, recenzji i redakcji manuskryptu, nadzorze oraz administracji projektu,

W pracy Lipowski P, Ostrowski A, Adamowicz J, Kowalski F, Drewa T, Juszczak K. Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review. Cancers (Basel). 2025 May 22;17(11):1746. doi:10.3390/cancers17111746 mój udział polegał na analizie formalnej, recenzji i edycji, nadzorze, administracji projektu,

W pracy Lipowski P, Ostrowski A, Adamowicz J, Zaigrajewa A, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026; doi: 10.5173/ceju.2025.0163 mój udział polegał na recenzji i edycji pracy.

Dr hab. n. med. Kajetan Juszczak
SPECJALISTA UROLOG, FEBU
2436446

.....
(podpis)

Załącznik nr 5 do uchwały Nr 38 Senatu UMK z dnia 26 września 2023 r. w sprawie postępowania o nadanie stopnia doktora na Uniwersytecie Mikołaja Kopernika w Toruniu

Bydgoszcz, dnia 24.02.2026

Dr hab. n. med Jan Adamowicz prof. UMK

Klinika Urologii Ogólnej i Onkologicznej SU nr.1 im. dr A. Jurasza w Bydgoszczy

Rada Dyscypliny Nauki Medyczne
Uniwersytetu Mikołaja Kopernika
w Toruniu

Oświadczenie o współautorstwie

Niniejszym oświadczam, że

W pracy Lipowski P, Ostrowski A, Adamowicz J, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy? *Cancers*. 2025; 17(1):102.

https://doi.org/10.3390/cancers17010102 mój udział polegał na walidacji, recenzji i edycji manuskryptu.

W pracy Lipowski P, Ostrowski A, Adamowicz J, Kowalski F, Drewa T, Juszczak K. Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review. Cancers (Basel). 2025 May 22;17(11):1746. doi:10.3390/cancers17111746 mój udział polegał na walidacji, recenzji i edycji manuskryptu.

W pracy Lipowski P, Ostrowski A, Adamowicz J, Zaigrajewa A, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026; doi: 10.5173/ceju.2025.0163 mój udział polegał na oprogramowaniu oraz analizie danych.

Adamowicz

(podpis)

Załącznik nr 5 do uchwały Nr 38 Senatu UMK z dnia 26 września 2023 r. w sprawie postępowania o nadanie stopnia doktora na Uniwersytecie Mikołaja Kopernika w Toruniu

Bydgoszcz, dnia 25.02.2026

Prof. dr hab. n. med. Tomasz Drewa

Klinika Urologii Ogólnej i Onkologicznej SU nr.1 im. dr A. Jurasza w Bydgoszczy

Rada Dyscypliny Nauki Medyczne
Uniwersytetu Mikołaja Kopernika
w Toruniu

Oświadczenie o współautorstwie

Niniejszym oświadczam, że

W pracy Lipowski P, Ostrowski A, Adamowicz J, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy? *Cancers*. 2025; 17(1):102. https://doi.org/10.3390/cancers17010102 mój udział polegał na konceptualizacji, walidacji, recenzji i edycji manuskryptu oraz nadzorze.

W pracy Lipowski P, Ostrowski A, Adamowicz J, Kowalski F, Drewa T, Juszczak K. Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review. Cancers (Basel). 2025 May 22;17(11):1746. doi:10.3390/cancers17111746 mój udział polegał na walidacji i nadzorze.

W pracy Lipowski P, Ostrowski A, Adamowicz J, Zaigrajewa A, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026; doi: 10.5173/ceju.2025.0163 mój udział polegał na walidacji i nadzorze.

.....
(podpis)

Załącznik nr 5 do uchwały Nr 38 Senatu UMK z dnia 26 września 2023 r. w sprawie postępowania o nadanie stopnia doktora na Uniwersytecie Mikołaja Kopernika w Toruniu

Bydgoszcz, dnia 26.02.2026

Lek. Anastazja Zaigrajewa

Klinika Urologii Ogólnej i Onkologicznej SU nr.1 im. dr A. Jurasza w Bydgoszczy

Rada Dyscypliny Nauki Medyczne
Uniwersytetu Mikołaja Kopernika
w Toruniu

Oświadczenie o współautorstwie

Niniejszym oświadczam, że w pracy Lipowski P, Ostrowski A, Adamowicz J, Zaigrajewa A, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026; doi: 10.5173/ceju.2025.0163 mój udział polegał na analizie danych.

Anastazja Zaigrajewa
.....
(podpis)

Załącznik nr 5 do uchwały Nr 38 Senatu UMK z dnia 26 września 2023 r. w sprawie postępowania o nadanie stopnia doktora na Uniwersytecie Mikołaja Kopernika w Toruniu

Bydgoszcz, dnia 28.02.2026

Dr n. med. Przemysław Jasiewicz

Klinika Anestezjologii i Intensywnej Terapii SU nr.1 im. dr A. Jurasza w Bydgoszczy

Rada Dyscypliny Nauki Medyczne
Uniwersytetu Mikołaja Kopernika
w Toruniu

Oświadczenie o współautorstwie

Niniejszym oświadczam, że:

W pracy Lipowski P, Ostrowski A, Adamowicz J, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy? *Cancers*. 2025; 17(1):102. https://doi.org/10.3390/cancers17010102 mój udział polegał na zdobywaniu zasobów i wizualizacji.

W pracy Lipowski P, Ostrowski A, Adamowicz J, Zaigrajewa A, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026; doi: 10.5173/ceju.2025.0163 mój udział polegał na analizie danych i wizualizacji.

Przemysław Jasiewicz
(podpis)

dr n. med. Przemysław Jasiewicz
specjalista anestezjologii i intensywnej terapii
2293148

Załącznik nr 5 do uchwały Nr 38 Senatu UMK z dnia 26 września 2023 r. w sprawie postępowania o nadanie stopnia doktora na Uniwersytecie Mikołaja Kopernika w Toruniu

Bydgoszcz, dnia 25.02.2026

Dr n med. Adam Ostrowski

Klinika Urologii Ogólnej i Onkologicznej SU nr.1 im. dr A. Jurasza w Bydgoszczy

Rada Dyscypliny Nauki Medyczne
Uniwersytetu Mikołaja Kopernika
w Toruniu

Oświadczenie o współautorstwie

Niniejszym oświadczam, że:

W pracy Lipowski P, Ostrowski A, Adamowicz J, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy? *Cancers*. 2025; 17(1):102.

https://doi.org/10.3390/cancers17010102 mój udział polegał na metodologii, oprogramowaniu, analizie formalnej, przeglądzie, redakcji i wizualizacji.

W pracy Lipowski P, Ostrowski A, Adamowicz J, Kowalski F, Drewa T, Juszczak K. Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review. Cancers (Basel). 2025 May 22;17(11):1746. doi:10.3390/cancers17111746 mój udział polegał na kocepcji, metodologii, redakcji i wizualizacji.

W pracy Lipowski P, Ostrowski A, Adamowicz J, Zaigrajewa A, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026; doi: 10.5173/ceju.2025.0163 mój udział polegał na metodologii, przeglądzie oraz redakcji.

dr n.med. Adam Ostrowski
FEBU, specjalista urolog
PWZ 2611057

.....
(podpis)

Załącznik nr 5 do uchwały Nr 38 Senatu UMK z dnia 26 września 2023 r. w sprawie postępowania o nadanie stopnia doktora na Uniwersytecie Mikołaja Kopernika w Toruniu

Bydgoszcz, dnia 24/02/26

Dr n. med. Filip Kowalski

Klinika Urologii Ogólnej i Onkologicznej SU nr.1 im. dr A. Jurasza w Bydgoszczy

Rada Dyscypliny Nauki Medyczne
Uniwersytetu Mikołaja Kopernika
w Toruniu

Oświadczenie o współautorstwie

Niniejszym oświadczam, że:

W pracy Lipowski P, Ostrowski A, Adamowicz J, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Does the Administration of Intravenous Fluid Matter in the Context of the Incidence of Postoperative Complications After Radical Cystectomy? *Cancers*. 2025; 17(1):102. https://doi.org/10.3390/cancers17010102 mój udział polegał na oprogramowaniu i wizualizacji.

W pracy Lipowski P, Ostrowski A, Adamowicz J, Kowalski F, Drewa T, Juszczak K. Impact of Perioperative Fluid Strategies on Outcomes in Radical Cystectomy: A Systematic Review. Cancers (Basel). 2025 May 22;17(11):1746. doi:10.3390/cancers17111746 mój udział polegał na oprogramowaniu oraz analizie danych.

W pracy Lipowski P, Ostrowski A, Adamowicz J, Zaigrajewa A, Jasiewicz P, Kowalski F, Drewa T, Juszczak K. Postoperative complications following simple cystectomy for radiation-induced bladder dysfunction compared to radical cystectomy: A matched cohort study. Cent European J Urol. 2026; doi: 10.5173/ceju.2025.0163 mój udział polegał na oprogramowaniu oraz analizie danych.

Kowalski Filip
.....
(podpis)