

# A systematic review and meta-analysis of the long-term outcomes of ileal conduit and orthotopic neobladder urinary diversion

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## Abstract

**Introduction:** We aimed to perform a systematic review and meta-analysis on the long-term durability, incidence of complications, and patient satisfaction outcomes in ileal conduit (IC) and orthotopic neobladder (ONB).

**Methods:** A systematic electronic literature search was performed in Medline, Embase, Cochrane Library, and Scopus using MeSH and free-text search terms “Urinary diversion” AND “Ileal conduit” AND “Neobladder.” The search concluded June 19, 2018. Inclusion criteria were those patients who had a cystectomy and required urinary diversion by either IC or neobladder.

**Results:** In total, 32 publications met the inclusion criteria. Data were available on 46 787 patients (n=36 719 for IC and n=10 068 for ONB). Meta-analyses showed that IC urinary diversions performed less favorably than ONB in terms of re-operation rates, Clavien-Dindo complications, and mortality rates; odds ratios (ORs) and 95% confidence intervals (CIs) were 1.76 (1.24, 2.50), p<0.01; 1.16 (1.09, 1.22), p<0.01; and 6.29 (5.30, 7.48), p<0.01, respectively. IC urinary diversion performed better than ONB in relation to urinary tract infection rates and ureteric stricture rates, OR and 95% CI 0.67 (0.58, 0.77), p<0.01; and 0.70 (0.55, 0.89), p<0.01, respectively.

**Conclusions:** Our results show that there is no significantly increased morbidity with ONB compared to IC. Selection of either urinary diversion technique should be based on factors such as tumor stage, comorbidities, surgical experience, and patient acceptance of postoperative sequelae.

## Introduction

There are many conditions that necessitate removal of the urinary bladder using cystectomy.<sup>1</sup> The most common indication is cancer of the urinary bladder but in some cases, cystectomy is indicated to treat benign disease such as interstitial cystitis.<sup>1</sup> Cystectomy, therefore, requires replacement of the urinary bladder with a procedure known as urinary

diversion.<sup>1</sup> Urinary diversion is a form of urinary reconstruction and most commonly involves the use of a gastrointestinal (GI) segment to replace part or all of the function of the urinary bladder.<sup>1</sup> An optimal bladder replacement should be able to hold large intravesical volumes while maintaining low pressure values in order to restore normal function and preserve the upper urinary tracts.<sup>1</sup>

Lifelong postoperative complications are common with any type of urinary diversion.<sup>1</sup> These can be divided into three broad groups: 1) metabolic complications due to the intestinal segment’s resorptive capacity; 2) neuromechanical aspects, which affect storage volume and diversion compliance; and 3) technical-surgical complications, which result in postoperative morbidity.<sup>1</sup>

Ileal conduit (IC) has long been considered the gold standard for replacement of the urinary bladder. However, orthotopic neobladder (ONB) has a superior cosmetic appearance and better preservation of body image.<sup>2</sup> The aim of this systematic review and meta-analysis is to perform a robust comparison of IC and ONB urinary diversion and to provide practitioners with a summary of the global trends for reconstructive preferences in urinary diversion.

## Methods

### Search strategy

This review was planned and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).<sup>3</sup>

A systematic electronic literature search was carried out in Medline, Embase, Cochrane Library, and Scopus. Using MeSH and free-text terms, the search strategy was: “Urinary diversion” AND “Ileal conduit” AND “Neobladder.” Titles and abstracts retrieved by the June 2018 search were screened independently by two authors (EB and ND), following the removal of duplicates. Where there was any uncertainty regarding inclusion, full-texts were retrieved and assessed for inclusion. Excluded studies were listed, with reasons given for their exclusion. Disagreements

regarding the inclusion or exclusion of an article were resolved by discussion.

### Eligibility criteria

Inclusion criteria were those patients who have had a cystectomy for any reason and required urinary diversion by either IC or ONB. Exclusion criteria were review articles, case reports, commentaries, letters, conference abstracts without sufficient outcome data and failure to meet the inclusion criteria.

### Data extraction and outcomes

The following data were extracted from each study: author's name, journal of publication, year of publication, country of origin, study type, total number of patients, and patient demographics (age, sex, body mass index [BMI]). Information regarding the outcomes listed below were recorded from each eligible study. The primary outcome measures were quality of life, measures of long-term durability (including re-operation, urinary tract infections [UTI], and ureteric stricture), postoperative morbidity, postoperative mortality, and length of stay. Secondary outcome measures were physiological changes, including active reflux, mucous, upper tract dilatation/hydronephrosis, renal scarring, metabolic changes, urinary stones, and health economics.

### Statistical analysis

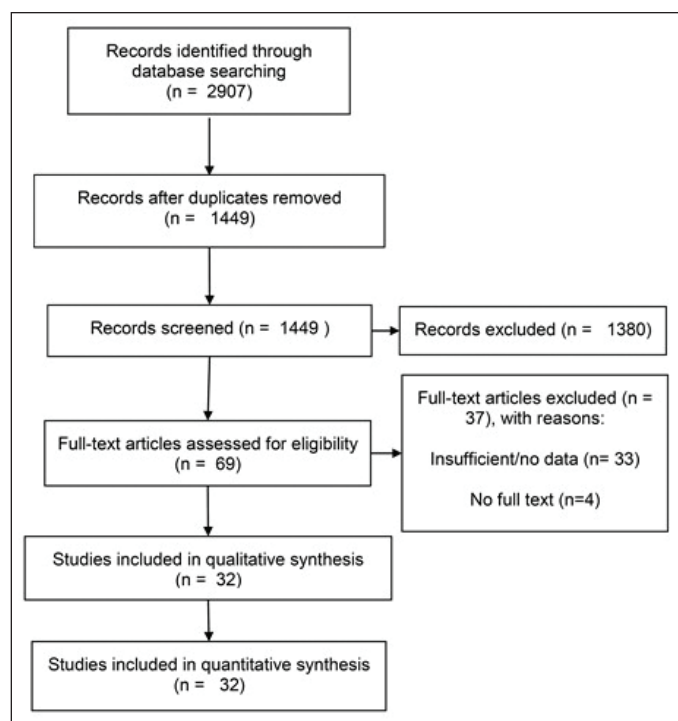
Data were presented as a mean  $\pm$  standard deviation (SD) for continuous variables. Differences between outcomes measured were considered significant at  $p < 0.05$ . Meta-analysis was performed with Review Manager Version 5.3 software.<sup>4</sup> The Mantel-Haenszel model was used for meta-analysis of dichotomous data and the inverse variance model for meta-analysis of continuous data.<sup>5</sup>

## Results

### Eligible studies

In total, 2907 articles were identified. Following the removal of duplicates ( $n=1458$ ), 1449 articles were screened, of which 1417 were excluded, as they did not meet the inclusion criteria. In total, 32 articles were included in the qualitative and quantitative analysis; see the PRISMA diagram in Fig. 1 for the flow of studies through the review and the reasons for which studies were excluded.

Data were available for 46 787 patients in the studies included in this review ( $n=36\ 719$  for IC and  $n=10\ 068$  for ONB). Study characteristics are summarized in Table 1. In total, there were 16 prospective case-control studies,<sup>6-21</sup> one



**Fig 1.** PRISMA diagram for the flow of studies through the review and the reasons for which studies were excluded.

of which was a prospective case-control study with matched-pair analysis,<sup>20</sup> and 16 retrospective case-control studies.<sup>2,22-36</sup>

Patient demographics (including patient age, male to female ratio, and patient BMI) were reported, if available; these are outlined in Tables 2 and 3. The mean patient age between the IC and ONB groups was significantly different,  $69.65 \pm 5.84$  in the IC group vs.  $61.07 \pm 4.47$  in the ONB group (95% confidence interval [CI] 8.44, 8.71,  $p < 0.01$ ), with patients undergoing IC urinary diversion being older overall. The mean BMI of the IC and ONB groups were significantly different,  $25.7 \pm 4.6$  in the IC group vs.  $23.7 \pm 3.3$  in the ONB group (95% CI 175, 2.25,  $p < 0.01$ ). The sex ratio in both groups was significantly different (11:2 male:female in the IC group vs. 11:1 male:female in the ONB group,  $p < 0.01$ ).

### Primary outcomes

#### Quality of life

Patient satisfaction, general measures of health status and disease specific measures of quality of life were not reported in a standardized manner across the studies. This precludes meaningful statistical analysis. Of the 32 included publications, five compared quality of life in patients with either diversion type.<sup>13,18,24,34,35</sup> Using The European Organization for Research and Treatment of Cancer (EORTC) QLQ-C30 questionnaire,<sup>37</sup> Navarro et al found a better acceptance in ONB vs IC.<sup>13</sup> The scale used by the authors rates overall quality of life

**Table 1. Summary of studies included in the meta-analysis for ileal conduit and orthotopic neobladder**

Author (year)	Origin	Journal	Type of study	Level of evidence	IC (n)	ONB (n)
Abe et al, 2014	Japan	<i>Int J Urol</i>	RCC	3b	493	175
Aboumarzouk et al, 2014	Poland	<i>Cent European J Urol</i>	PCC	3b	39	24
Angulo et al, 2014	Spain	<i>Urology</i>	PCC	3b	8	12
Antonelli et al 2016	Italy	<i>Clin Genitourin Cancer</i>	PCC	3b	85	85
Belotti et al, 2012	Italy	<i>Anticancer Research</i>	PCC	3b	223	111
Cho et al, 2017	Korea	<i>Renal Failure</i>	RCC	3b	33	62
Collins et al, 2013	Sweden	<i>Eur Urol</i>	PCC	3b	43	70
De Nunzio et al, 2013	Italy	<i>Eur J Surg Oncol</i>	PCC	3b	217	112
Decaestecker et al, 2016	Belgium	<i>European Urology, Supplements</i>	PCC	3b	40	32
Erber et al, 2012	Germany	<i>IRSN Urol</i>	RCC	3b	23	34
Gburek et al, 1998	USA	<i>Journal of Urology</i>	RCC	3b	66	66
Gore et al, 2010	USA	<i>Journal of Urology</i>	RCC	3b	1252	109
Hofer et al, 2012	USA	<i>Journal of Urology</i>	PCC	3b	245	63
Jung et al, 2006	Korea	<i>Korean Journal of Urology</i>	PCC	3b	29	19
Kim et al, 2014	Korea	<i>Jpn J Clin Oncol</i>	RCC	3b	161	147
Mano et al, 2018	Israel	<i>Urology</i>	RCC	3b	130	49
Monn et al, 2014	USA	<i>Urologic Oncology: Seminars and Original Investigations</i>	RCC	3b	139	55
Nahar et al, 2018	USA	<i>Journal of Urology</i>	RCC	3b	10197	692
Navarro et al, 2008	Chile	<i>Urology</i>	PCC	3b	17	37
Nazmy et al, 2013	USA	<i>Journal of Urology</i>	PCC	3b	67	91
Nieuwenhuijzen et al, 2008	The Netherlands	<i>Eur Urol</i>	PCC	3b	118	62
Parekh et al, 2000	USA	<i>Urology</i>	RCC	3b	81	117
Popov et al, 2007	Republic of Macedonia	<i>Acta chirurgica iugoslavica</i>	RCC	3b	32	52
Prcic et al, 2017	Bosnia and Herzegovina	<i>Med Arch</i>	PCC	3b	66	60
Roghmman et al, 2013	USA	<i>Can Urol Assoc J</i>	RCC	3b	18782	6282
Roghmman et al, 2014	Germany	<i>Int J Urol</i>	RCC	3b	349	186
Roghmman et al, 2017	Germany	<i>Journal of Urology</i>	PCC	3b	510	294
Sherwani et al, 2009	India	<i>Int J Health Sci (Qassim)</i>	PCC	3b	13	4
Sogni et al, 2008	Italy	<i>Urology</i>	RCC	3b	53	32
Tan et al, 2017	United Kingdom	<i>Eur Urol Focus</i>	PCC	3b	100	34
Thulin et al, 2010	Sweden	<i>BJU Int</i>	RCC	3b	190	180
van Hemelrijck et al, 2013	Sweden	<i>BJU Int</i>	RCC	3b	2918	720

IC: ileal conduit; ONB: orthotopic neobladder; PCC: prospective case-control; RCC: retrospective case-control.

on a seven-point scale, where 1=very poor and 7=excellent.<sup>37</sup> Sogni et al also used the QLQ-C30 questionnaire, as well as the bladder cancer-specific module EORTC QLQ-muscle-invasive bladder cancer module 30 (BLM 30)<sup>38</sup> and found that the quality of life reported in both groups was comparable but with a non-significant higher quality of life rating seen in the ONB group.<sup>34</sup> Erber et al also used the QLQ-C30 questionnaire and reported overall quality of life as 58±25.3 in the IC group and 72.3±19.5 in the ONB group.<sup>24</sup> Sherwani et al used a simple satisfaction scale of “very good,” “good,” “poor” to compare quality of life between the two groups and reported higher ratings in the ONB group.<sup>18</sup> Finally, Thulin et al had patients rate quality of life as “high,” “moderate,” or “low.”<sup>35</sup> Of these, 68% of patients with an ONB reported their quality of life as “high” compared to 53% of IC recipients.

### Measures of long-term durability

The measures of long-term durability included in this review were re-operation rates, UTI rates, and ureteric stricture rates. The meta-analysis of these outcomes are detailed in Fig. 2.

Of the 32 studies included in this review, nine examined re-operation rates. The rate of re-operation was significantly greater in patients with an IC compared to patients undergoing ONB formation (odds ratio [OR] 1.76, 95% CI 1.24, 2.50,  $p<0.01$ ) (Fig. 2A).

The incidence of UTI rates was reported in 11 studies. The incidence of UTI was significantly less in patients with an IC vs. patients with an ONB ( $n=1048/4013$ , 26.1% vs.  $n=433/1425$ , 30.4%, respectively; OR 0.67, 95% CI 0.58, 0.77,  $p<0.01$ ) (Fig. 2B).

**Table 2. Patient demographics from papers where age was reported as a mean  $\pm$  standard deviation**

Author (year)	Age (conduit)	Age (neobladder)	Male/female (conduit)	Male/female (neobladder)	BMI (conduit)	BMI (neobladder)
Aboumarzouk et al, 2014	60 $\pm$ 7.11	57 $\pm$ 8.68	34/5	24/0	27.2 $\pm$ 2.3	27.96 $\pm$ 2
Antonelli A, et al 2016	63 $\pm$ 8.8	63.5 $\pm$ 6.7	69/16	72/13	NR	NR
Belotti et al, 2012	70.4 $\pm$ 8.1	60.6 $\pm$ 0.9	183/34	90/21	26.3 $\pm$ 4.3	26.3 $\pm$ 3.6
Cho et al, 2017	69.5 $\pm$ 8.1	64.5 $\pm$ 8.6	23/10	52/10	NR	NR
Collins et al, 2013	69.9 $\pm$ 6.7	59.8 $\pm$ 9.0	31/11	62/8	24.8 $\pm$ 3.1	26.1 $\pm$ 3.4
De Nunzio et al, 2013	71 $\pm$ 9.75*	63 $\pm$ 0.25*	NR	NR	26.4 $\pm$ 6*	25 $\pm$ 3.25*
Decaestecker et al, 2016	71 $\pm$ 1.5*	63 $\pm$ 1.25*	29/11	27/5	26 $\pm$ 4.25*	26 $\pm$ 3.75*
Gburek B et al, 1998	69 $\pm$ 11.75*	62 $\pm$ 12.75*	66/0	62/4	NR	NR
Hofer et al, 2012	69.7 $\pm$ 3.75*	59.7 $\pm$ 15	NR	NR	NR	NR
Jung et al, 2006	65.6 $\pm$ 9.9	60.8 $\pm$ 8.3	NR	NR	NR	NR
Kim et al, 2014	67.1 $\pm$ 8.9	59.4 $\pm$ 9.4	115/32	156/5	23.6 $\pm$ 3.3	24 $\pm$ 3.1
Monn et al, 2014	72.6 $\pm$ 10	59.6 $\pm$ 9	107/32	49/6	NR	NR
Nahar et al, 2018	68.8 $\pm$ 10.1	62.8 $\pm$ 10	8835/1362	663/29	NR	NR
Parekh et al, 2000	68 $\pm$ 12.75*	60 $\pm$ 13.5*	48/33	97/20	NR	NR
Roghamann et al, 2013	69.6	60.8	81/19	91/9	NR	NR
Sherwani et al, 2009	59	53.3	NR	NR	NR	NR
Thulin et al, 2010	70.1	64.3	134/56	165/15	NR	NR

\*Estimated standard deviation based on the Range Rule of Thumb. BMI: body mass index; NR: not reported.

Ureteric stricture rates in both groups were reported in nine publications. The incidence of the ureteric stricture was statistically less significant in patients undergoing IC urinary diversion vs. patients with ONB (n=249/3533, 7.0% vs. n=109/1241, 8.8%, respectively; OR 0.70, 95% CI 0.55, 0.89, p<0.01) (Fig. 2C).

### Complications

Postoperative morbidity, reported in 21 publications, was described using the Clavien-Dindo classification in 12 publications.<sup>6,7,10,14,15,19-22,26,28,33,39</sup>

The incidence of postoperative morbidity was significantly higher in patients undergoing IC urinary diversion vs. those undergoing ONB urinary diversion (n=15659/25264, 61.9% vs. n=5102/8478, 60.1%, respectively; OR 1.16, 95% CI 1.09, 1.22, p<0.01) (Fig. 3A). Subgroup analysis of patients who suffered Clavien-Dindo 1–2 (minor) complica-

tions showed that patients undergoing IC were less likely to suffer a minor complication than those undergoing ONB urinary diversion, although this was not statistically significant (n=1016/1802, 56.4% vs. n=573/1029, 55.7%, respectively; OR 0.89, 95% CI 0.75, 1.06, p=0.21) (Fig. 3B). Subgroup analysis of those who suffered Clavien-Dindo 3–5 (major) complications showed that patients with IC were significantly more likely to suffer a major complication than those with ONB (n=375/1802, 20.8% vs. n=184/1029, 17.9%, respectively; OR 1.25, 95% CI 1.02, 1.53, p=0.03) (Fig. 3C).

### Mortality

Postoperative mortality was reported in 21 publications. The mortality rate in patients with IC urinary diversion was significantly higher than that of patients undergoing ONB (n=3227/33656, 9.6% vs. n=142/8810, 1.6%, respectively; OR 6.29, 95% CI 5.30, 7.48, p<0.01) (Fig. 4).

**Table 3. Patient demographics from papers where age was reported as a median and range**

Author (year)	Age (conduit)	Age (neobladder)	Male/female (conduit)	Male/female (neobladder)	BMI (conduit)	BMI (neobladder)
Abe et al, 2014	70 (37–89)	63 (25–86)	364/129	164/11	23 (14.6–35.1)	23.3 (16–31.5)
Angulo et al, 2014	74.5 (70–82.2)	66 (61.5–75)	5/3	12/0	27.7 (23.2–31.8)	27.3 (25.5–28.5)
Erber et al, 2012	70 (64–75)	62 (56–66)	98/48	110/5	NR	NR
Mano et al, 2018	72 (65–78)	60 (53–65)	112/18	43/6	NR	NR
Nieuwenhuijzen et al, 2008	70 (46–85)	62 (32–73)	88/30	59/3	NR	NR
Roghamann et al, 2014	72 (67–76)	61 (55–67)	256/93	158/28	27.3 (24.6–29.8)	26.1 (23.8–29.2)
Sogni et al, 2008	78.9 (75–88)	77.5 (75–82)	NR	NR	NR	NR
Tan et al, 2017	67.4 (60.4–74.3)	54.5 (48.6–61.6)	75/25	28/6	27.2 (23.4–31)	27.3 (23–28.5)

BMI: body mass index; NR: not reported.

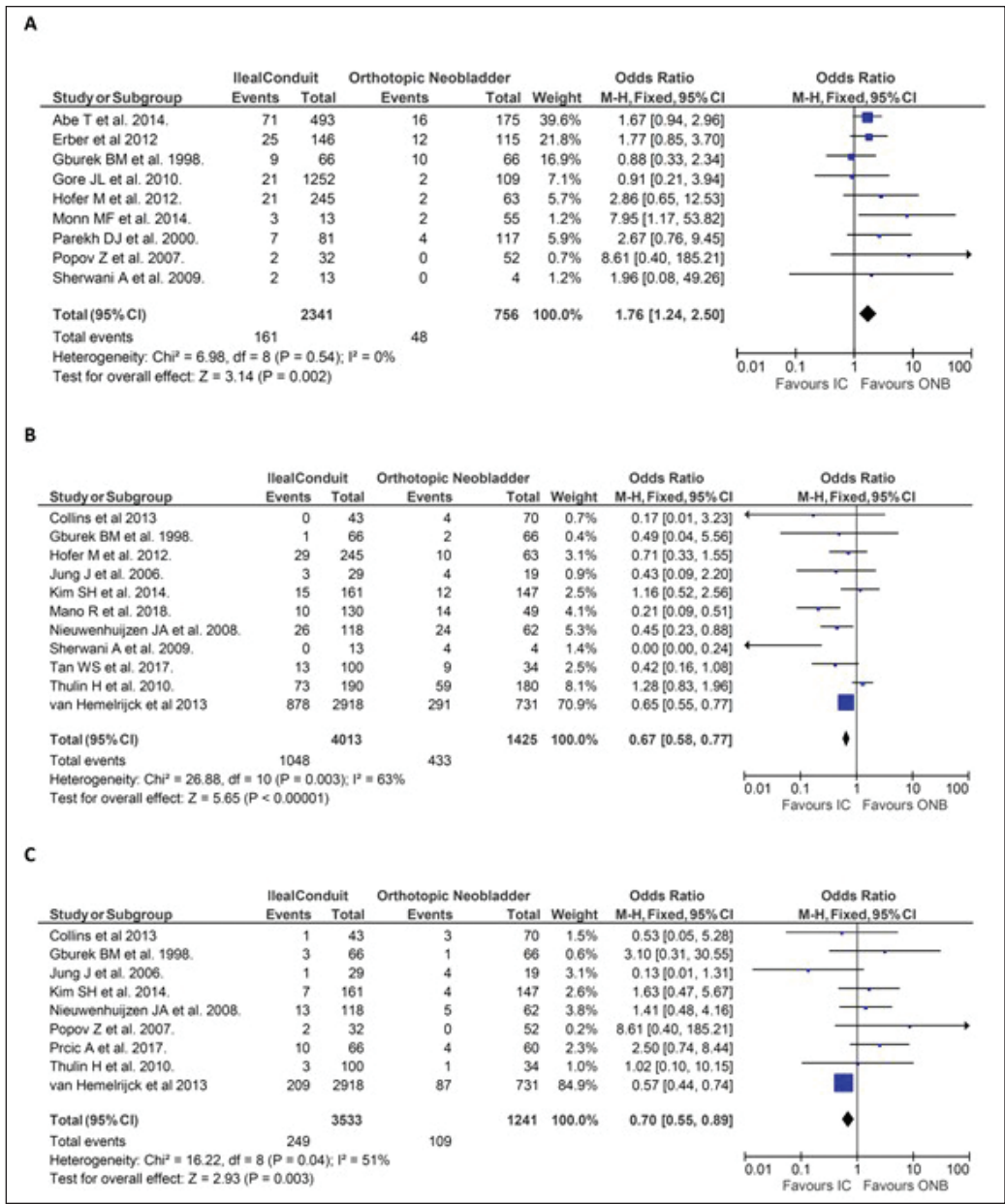


Fig. 2. Primary outcomes in the ileal conduit (IC) vs. orthotopic neobladder (ONB) cohorts included in the review: (A) rate of re-operation; (B) incidence of urinary tract infection; and (C) incidence of ureteric stricture. CI: confidence interval.

**Length of stay**

Seven publications reported length of stay IC and ONB groups as a mean ± SD (Fig. 5). Length of stay was shorter in the IC group compared to the orthotopic neobladder group (17.56±8.61 days vs. 19.93±7.85 days, respectively), with a mean difference of -0.74 (95% CI -1.30, -0.18, p<0.01).

Eleven other publications reported length of stay as median and range and these are outlined in Table 4.

95% CI 0.08, 3.98, p=0.58) (Fig. 6C). This was not statistically significant.

The incidence of metabolic change is less in patients with an IC vs. ONB (n=26/280, 4.5% vs. n=37/330, 11.2%, respectively: OR 0.57, 95% CI 0.32, 1.03, p=0.06) (Fig. 6D). This finding was also not statistically significant.

The incidence of urinary stones was lower in patients with IC urinary diversion compared to ONB (n=167/4719, 3.5% vs. n=85/1319, 6.4%, respectively; OR 0.49, 95% CI 0.37, 0.64, p<0.01) (Fig. 6E). This was statistically significant.

**Secondary outcomes**

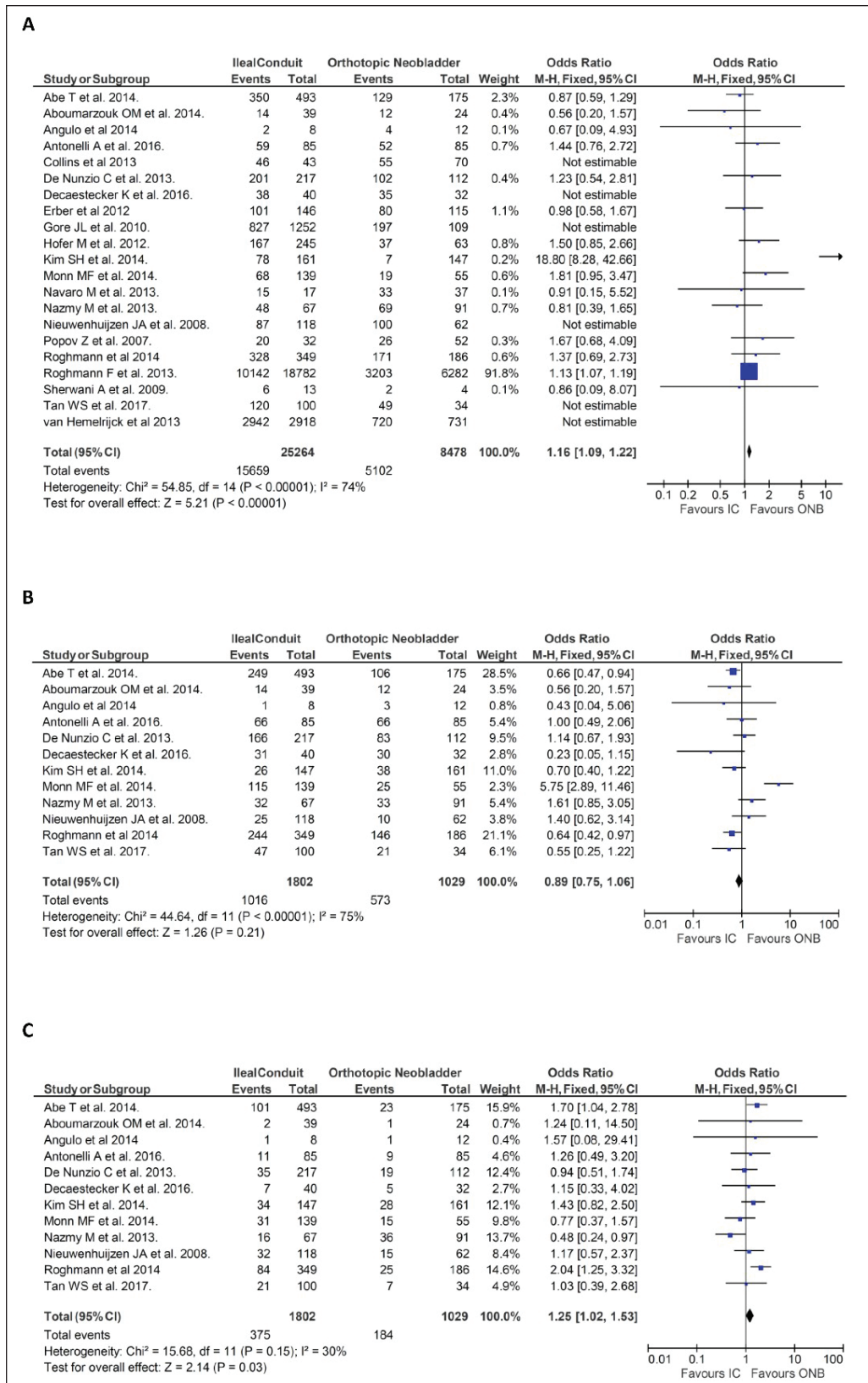
**Physiological changes**

For the purpose of this review, physiological changes following urinary diversion were defined as: active reflux, upper tract dilation or hydronephrosis, mucous, metabolic changes, urinary stones, and renal scarring.

The incidence of active reflux was reported in two of the 32 included publications and showed that patients undergoing IC urinary diversion were at lower risk of active reflux than those undergoing ONB, although this was not statistically significant (n=0/147 vs. n=1/81, respectively; OR 0.17, 95% CI 0.01, 4.31, p=0.28) (Fig. 6A).

The incidence of upper tract dilatation/hydronephrosis was reported in three of the 32 included publications. Analysis shows that patients with IC urinary diversion were more likely to have hydronephrosis than those with ONB (n=23/568, 4.0% vs. n=9/297, 3.0%, respectively; OR 1.56, 95% CI 0.67, 3.62, p=0.30) (Fig. 6B), although again, not statistically significant.

The incidence of mucous production was less in patients with IC than those with ONB (n=1/135, 0.7% vs n=3/99, 3%, respectively: OR 0.58,



**Fig. 3.** Complications in the ileal conduit (IC) vs. orthotopic neobladder (ONB) cohorts reported in 21 publications of the review: **(A)** incidence of postoperative morbidity; **(B)** Clavien-Dindo 1–2 (minor) complications; **(C)** Clavien-Dindo 3–5 (major) complications. CI: confidence interval.

There were no data reported in any of the included studies regarding the incidence of renal scarring in patients with either urinary diversion.

**Health economics**

None of the studies included in this review examined or made any comment on the economic impact of either IC or ONB urinary diversion, precluding a comparison of cost of intervention or assessment of cost-benefit relationship.

**Discussion**

This study is a comprehensive review comparing IC and ONB urinary diversions. The choice of urinary diversion has significant implications for both the patient in terms of their future health and quality of life, and for the surgeon and their methods. The choice of which urinary diversion to use depends on many factors, such as surgical skill, urethral disease, or patient acceptance.<sup>1</sup> It is, therefore, imperative that a thorough comparison is made of the outcomes of IC and ONB to provide practitioners with a comprehensive summary of the data to aid surgical and patient decision-making.

Our review of the literature demonstrates that there is an overall preference towards IC urinary diversion and a tendency for this type of diversion to be performed in older patients. We also showed a higher re-operation rate and rate of postoperative morbidity and mortality in those patients who underwent an IC urinary diversions, however,

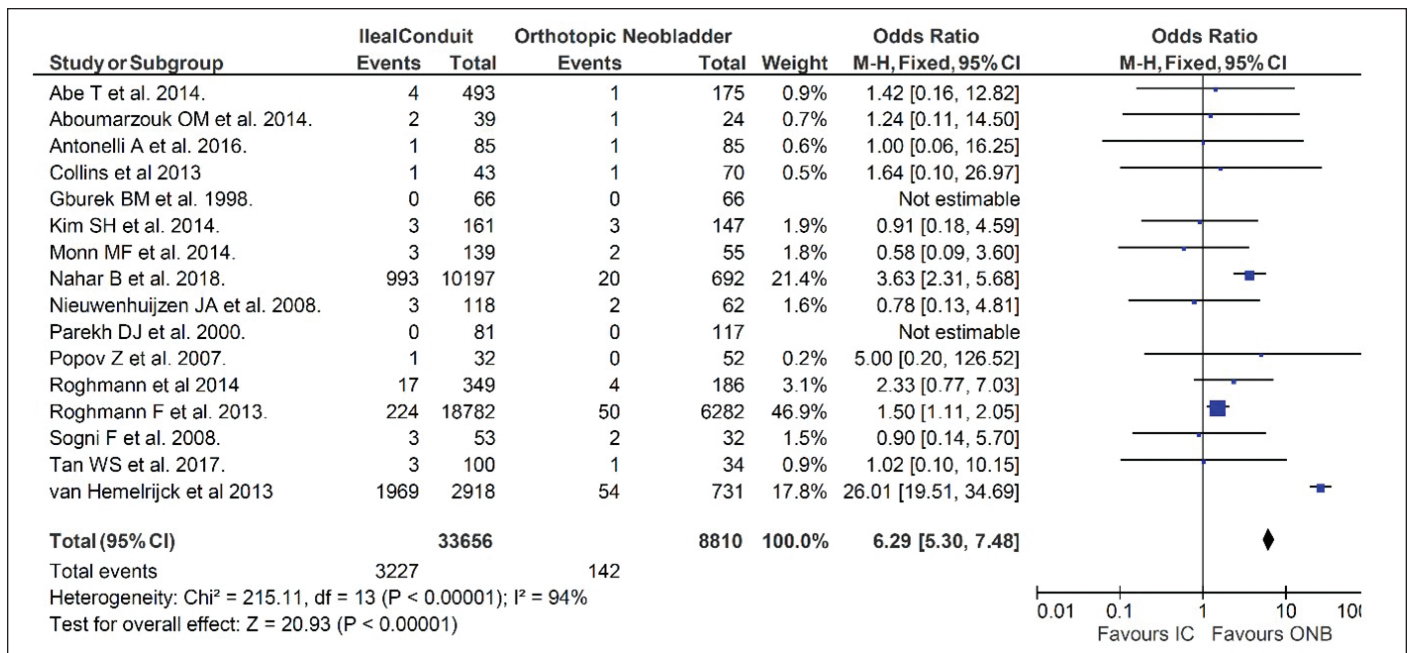


Fig. 4. Postoperative mortality in the ileal conduit (IC) vs. orthotopic neobladder (ONB) cohorts reported in 21 publications of the review. CI: confidence interval.

performed worse in terms of UTI, ureteric stricture, and urinary stone rates.

In this study, comparison of patient age in the two groups showed that patients with IC urinary diversion were significantly older than those patients undergoing ONB diversion. It can be reliably assumed that older patients have greater comorbidities so interpretation of results may be affected by this finding. Younger patients, likely with fewer comorbidities, tend to have a ONB diversion, possibly due to the widely accepted belief that ONB has a greater risk of perioperative complications due to its technical complexity.<sup>2</sup> This is, therefore, likely to confound data relating to postoperative complication rates in each group. The larger numbers of IC performed in these studies compared to ONB demonstrates the preference for IC as the choice of urinary diversion. This is likely to be multifactorial, as addressed previously, including patient preference, surgical skill, and other patient factors, such as age or comorbidity.

From the included publications, there was a better acceptance and quality of life in patients with ONB diversions than those with IC.<sup>40</sup> However, it is worth bearing in mind that each type of urinary diversion has inherently different challenges associated with it.<sup>6</sup> According to meta-analysis, there is a higher rate of UTI in the ONB group, potentially as ONB often requires self-catheterization, which comes with the associated risk of bacterial inoculation.<sup>35</sup> Meta-analysis also demonstrated a significantly higher risk of uretero-ileal stricture in patients with an ONB than those with an IC urinary diversion, possibly due to the use of an anti-reflux mechanism in uretero-intestinal anastomosis; however, an anti-reflux mechanism was only used for ONB in two of the publications included in this review. This highlights the importance of forming a low-pressure reservoir.<sup>1</sup>

The studies included for analysis in this review focused predominantly on reporting perioperative data regard-

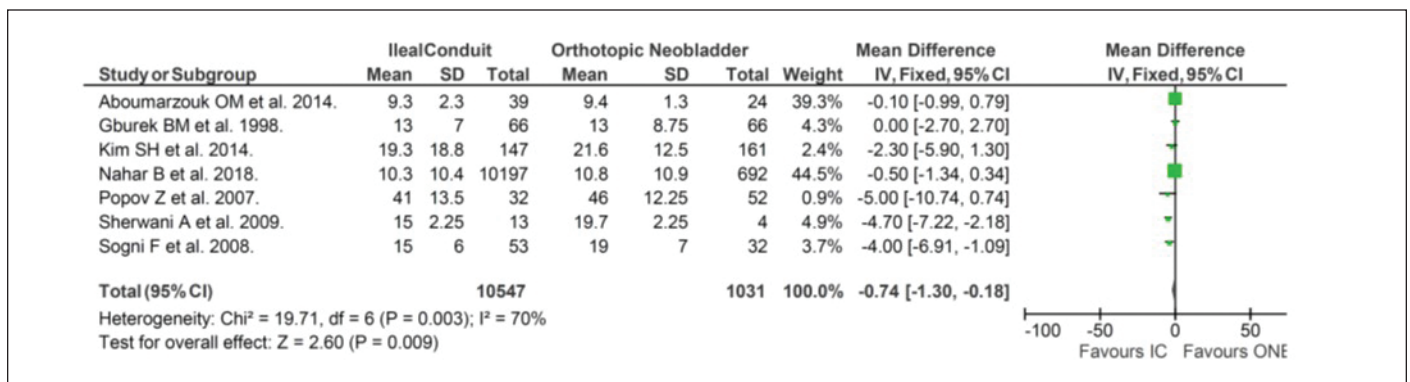
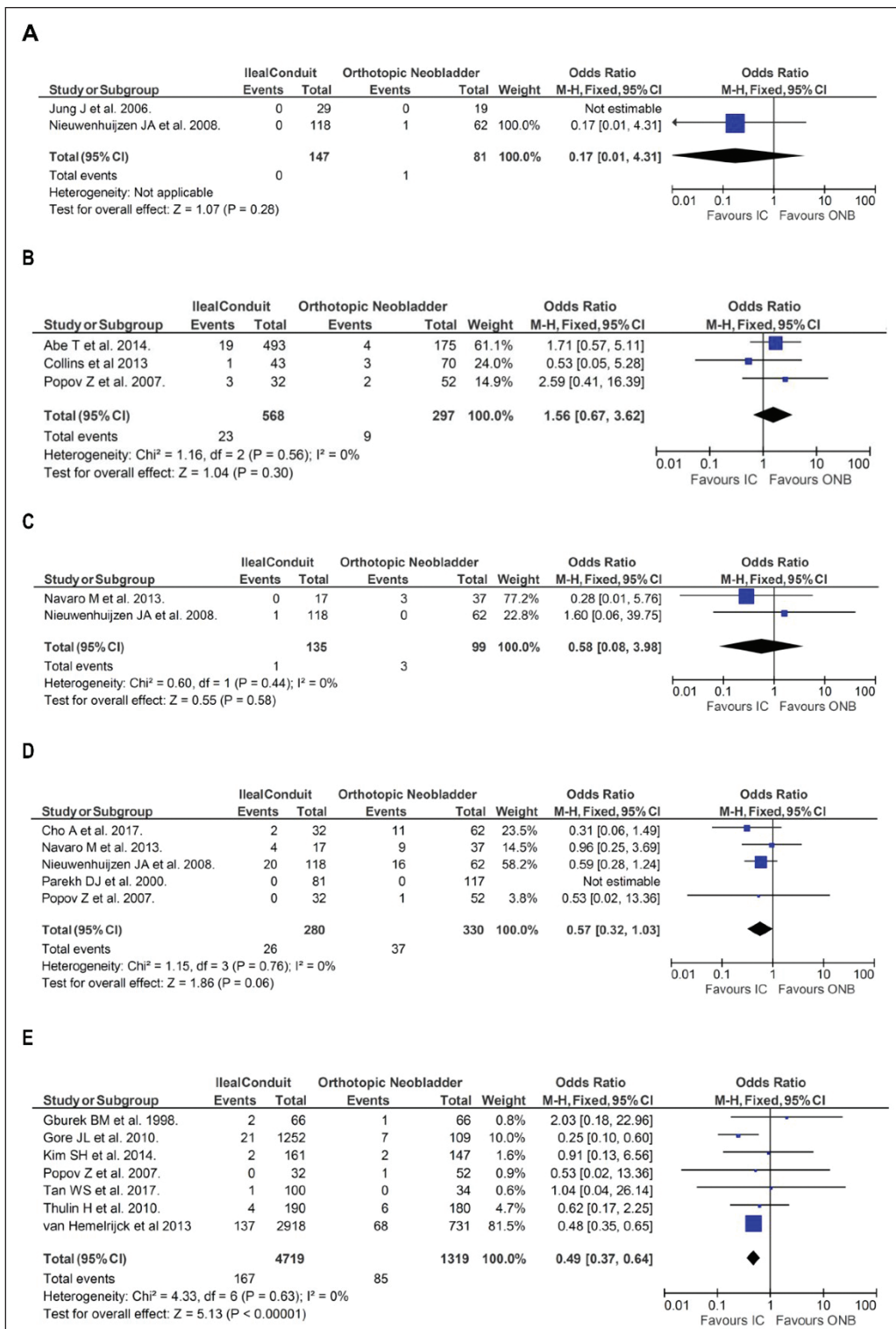


Fig. 5. Length of stay in the ileal conduit (IC) vs. orthotopic neobladder (ONB) cohorts reported in 7 publications of the review.



**Fig. 6.** Secondary outcomes in the ileal conduit (IC) vs. orthotopic neobladder (ONB) cohorts included in the review. Incidence of **(A)** active reflux; **(B)** upper tract dilatation/hydronephrosis; **(C)** mucous production; **(D)** metabolic change; **(E)** urinary stones. CI: confidence interval.

ing IC urinary diversion and ONB, revealing a dearth of information on long-term outcomes of these two types of

With the exception of stones (which were significantly more likely in ONB), meta-analysis of the physiological

urinary diversion. This may explain the paucity of evidence relating to the long-term complications of urinary diversion.<sup>1</sup> Meta-analysis of those publications that reported postoperative morbidity using Clavien-Dindo shows a significantly higher morbidity in IC compared to ONB.<sup>6,7,10,14,15,19-22,26,28,33</sup> This is potentially explained by noting that within this systematic review, patients undergoing IC tended to be older and have higher-grade tumors, which may increase the risk of death independent of diversion type. It must also be considered that minor (Clavien-Dindo 1–2) complications may be under-reported, given that many of the publications included in this review were retrospective case controls.<sup>27</sup>

Meta-analysis of mortality rates between IC and ONB urinary diversion showed a significantly increased risk of death in those patients undergoing IC diversion. However, patients undergoing IC tend to be older and have higher-grade tumours, which may increase the risk of death independent of diversion type.<sup>2</sup>

Meta-analysis of mean ± SD of length of stay demonstrated a significantly longer length of stay in patients undergoing ONB. Length of stay is sometimes dependent on the practice of individual institutions and, thus, it cannot be assumed that ONB urinary diversion always results in an increased length of stay; still, it is an important consideration when deciding which type of urinary diversion to use.



**Table 4. Studies where length of stay is reported as median and range**

Author (year)	Ileal conduit		Orthotopic neobladder	
	n	Median (range)	n	Median (range)
Abe et al, 2014	493	39 (3–257)	175	42 (18–364)
Angulo et al, 2014	8	9.5 (8–11)	12	8.5 (7.2–10.7)
Antonelli et al, 2016	85	17	85	21
Belotti et al, 2012	223	20 (16–24)	111	24 (20–29)
Collins et al, 2013	43	9 (6–142)	70	9 (4–78)
Decaestecker et al, 2016	40	10 (5–36)	32	11 (6–39)
Monn et al, 2014	139	8 (6–10)	55	7 (6–8)
Nieuwenhuijzen et al, 2008	118	17 (6–53)	62	15 (8–44)
Parekh et al, 2000	81	8 (5–60)	117	7 (5–28)
Rogghmann et al, 2014	349	19 (16–24)	70	9 (17–23)
Tan et al, 2017	100	10 (8–15.5)	34	11 (8.5–14)

changes considered in this review showed no statistically significant results. Nonetheless, consideration of physiological changes, such as hydronephrosis, vesicoureteric reflux, mucous production, metabolic changes, and urinary stones, is important when deciding between IC and ONB, particularly in patients with pre-existing conditions.

A cost-benefit comparison is a crucial aspect of assessing any intervention and there seems to be a complete lack of any such analysis in contemporary literature. This is certainly an aspect of urinary diversion that requires further study. In countries where universal or socialized healthcare does not exist, the type of urinary diversion a patient receives may depend on their ability to pay for this type.<sup>41</sup>

The main limitation of this meta-analysis is that the studies included for analysis consist of retrospective or prospective case-control studies. Other limitations include the small sample sizes contained within most publications, limiting the generalizability of the findings of this review and the non-standard reporting of outcomes. Thirdly, some data points were presented as median and range, which precluded any analysis regarding these figures. Lastly, there is the potential for significant selection bias in all publications in that those undergoing ONB have lower-stage tumors and would, therefore, have better postoperative outcomes in terms of recovery and mortality rates.<sup>20</sup>

However, this is a very robust analysis involving large numbers of patients with extensive followup, using standardized questionnaires, and involving data from multiple institutions. This analysis also includes international publications and so is representative of global trends for reconstructive preferences in urinary diversion.

## Conclusions

This systematic review and meta-analysis does not support the widely held perception that ONB is associated with increased risk of postoperative morbidity, however, the reason for this may be multifactorial. Our findings demonstrated that ONB was associated with a lower rate of major (Clavien-Dindo 3–5) complications than the IC. However, larger cohort studies are required to reach a definitive conclusion as to which type of diversion is superior. Our results also reinforce that the selection of urinary diversion should be based on careful preoperative counselling, taking into account patient factors (such as tumor stage and comorbidities), surgical skill, and patient acceptance of the sequelae of either type of urinary diversion.

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