

Article

# Diagnostic Performance of Urinary Dipstick Test for Haematuria in Low-Risk Non-Muscle-Invasive Bladder Cancer Surveillance

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## Abstract

**Introduction:** Low-risk non-muscle-invasive bladder cancer (NMIBC) is associated with extremely low rates of progression and cancer-specific mortality. Current surveillance strategies recommend yearly cystoscopic surveillance after the initial 12-month period. Cystoscopic surveillance is costly, leading bladder cancer to be one of the most economically burdensome diseases. We investigated the use of a negative urinary dipstick for haematuria (UDH) in predicting the absence of recurrence. **Materials and Methods:** All patients undergoing flexible cystoscopy at our institution underwent urinary dipstick testing immediately prior to their procedures. We conducted a retrospective analysis of all patients undergoing cystoscopic surveillance for known low-risk NMIBC at our institution between January 2018 and August 2024. All patients had low-risk NMIBC, as defined by American Urological Association (AUA) guidelines, at the time of flexible cystoscopy. Patient demographics, cystoscopy operation records, and subsequent biopsy results were reviewed. **Results:** A total of 124 patients who underwent 310 cystoscopies were included in the analysis. The overall rate of UDH positivity was 54%. The negative predictive value (NPV) and sensitivity of UDH for the absence of bladder cancer recurrence were 95.7% and 81.2%, respectively. All cases of bladder cancer recurrence with negative UDH were low-grade Ta ( $n = 5$ ) or papillary urothelial neoplasm of low malignant potential (PUNLMP) ( $n = 1$ ). There was no difference in the NPV and sensitivity within 12 months of diagnosis (NPV = 95.4%, sensitivity = 83.3%) and 12 months after diagnosis (NPV = 95.8%, sensitivity = 80%). **Conclusions:** UDH has a high NPV and sensitivity for recurrence in low-risk NMIBC. No cases of high-grade tumors or carcinoma in situ were undetected by UDH in this study. UDH shows promise as an inexpensive adjunct test that can reduce the high economic burden of surveillance of non-muscle-invasive bladder cancer.



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**Keywords:** bladder cancer; non-muscle-invasive bladder cancer; bladder cancer surveillance; cystoscopy; low-resource healthcare

## 1. Introduction

Non-muscle-invasive bladder cancer (NMIBC) comprises around 75% of all new bladder cancer diagnoses and is characterized by a high risk of recurrence [1]. As a result, patients require intensive and prolonged surveillance, typically involving frequent cystoscopic examination. Current guidelines from the European Association of Urology (EAU) and the American Urological Association (AUA) recommend cystoscopic surveillance every 3–12 months, depending on the recurrence risk and time since diagnosis [1,2]. Cystoscopic

examination is the gold standard for the detection of recurrence; however, in addition to it being an invasive procedure, cystoscopic examination is significantly resource- and time-intensive. The cost of a single outpatient flexible cystoscopy in the United Kingdom's National Health Service is approximately GBP 449 [3]. In the United States, the median 5-year cost of surveillance of low-risk non-muscle-invasive bladder cancer is estimated to be USD 52,100 per patient, and in the European Union bladder cancer is estimated to account for 5% of the overall healthcare costs for cancer [4,5]. The cumulative healthcare costs of NMIBC places it as one of the highest economic burden cancers to monitor over a patient's lifetime [6]. Cost-effective alternatives or adjuncts to reduce the number of cystoscopies a patient undergoes, without compromising patient safety, are therefore highly desirable.

Haematuria is a well-recognized presenting feature of bladder cancer. Among patients presenting with non-visible haematuria (NVH), the estimated incidence of underlying genitourinary malignancy is 5%, with bladder cancer accounting for the majority of cases [7,8]. While the role of haematuria in the initial detection of bladder cancer is well established, its utility in the surveillance of patients with previously diagnosed bladder cancer is less defined, with only two studies examining its role in the surveillance setting to date. The primary aim of this study was to determine the diagnostic performance of urine dipstick haematuria (UDH) testing for bladder cancer recurrence in patients undergoing surveillance for low-risk NMIBC. The secondary aim was to explore the potential economic benefits of substituting UDH testing for cystoscopic surveillance.

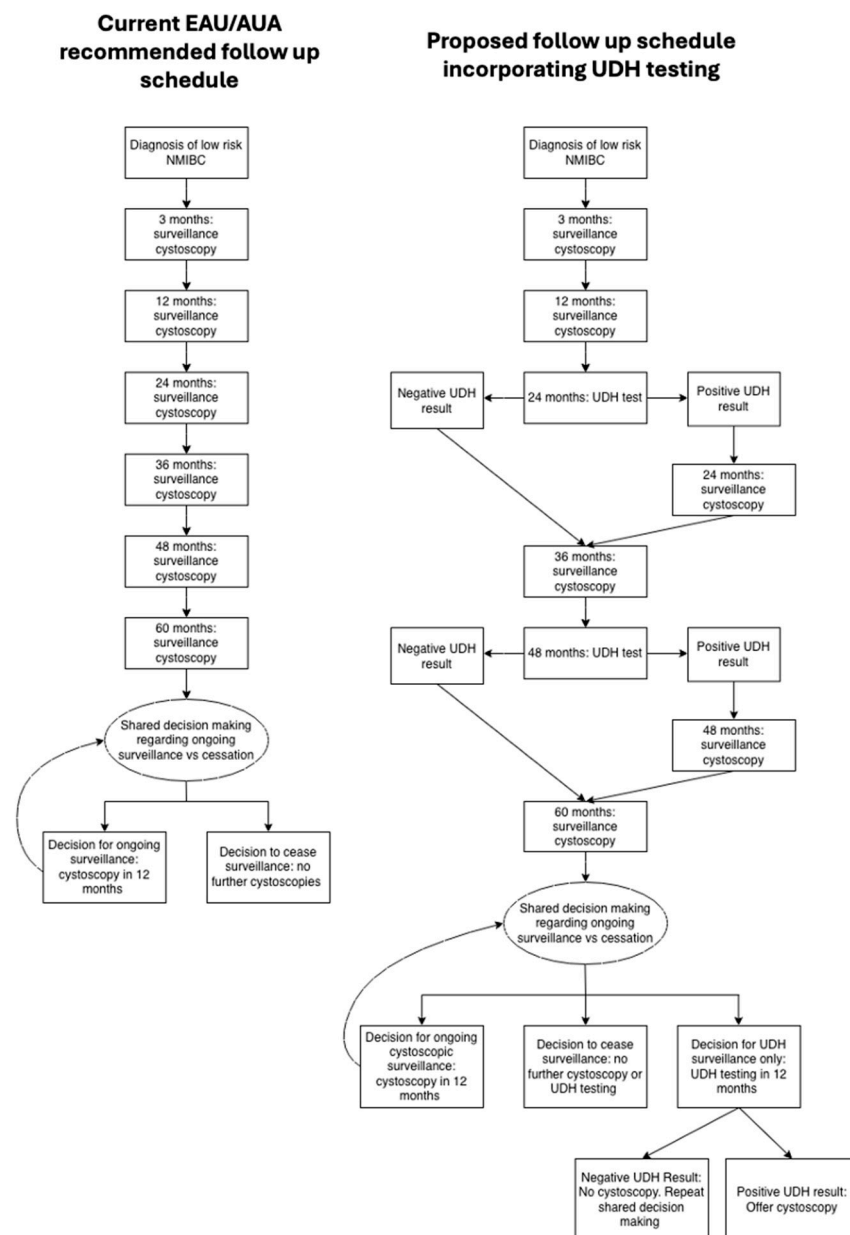
## 2. Materials and Methods

Consecutive adult patients undergoing flexible cystoscopy for the surveillance of NMIBC at our institution between January 2018 and June 2024 were identified. Patients were included for analysis if they met the criteria set by the AUA for low-risk non-muscle-invasive urothelial bladder cancer [2]. That is, they had a single Ta low-grade (LG)/G1 tumor less than three centimeters in diameter, without carcinoma in situ and without recurrence within 1 year [2]. Patients were included regardless of time since initial diagnosis. Risk categorization was defined prior to the findings of the flexible cystoscopy.

Patients were excluded if they had non-urothelial bladder cancer or a history of upper tract urothelial cancer. If a patient's risk category changed to intermediate or high risk during the follow-up period, subsequent cystoscopies were not included. Patients with a urine dipstick test positive for nitrites were excluded from the analysis. Other urine dipstick indicators, including leukocyte esterase, were not used for the inclusion/exclusion of patients.

Patients were identified using a prospective register of operative records. Patient, operative, and histopathological data were retrospectively retrieved from electronic medical records. Every flexible cystoscopy during the study period was assessed for inclusion. Within 90 min prior to the flexible cystoscopy, patients were instructed by a registered nurse (RN) to collect a clean midstream urine sample in a sterile container. Following manufacturer guidelines, a Siemens Multistix 10 SG (Siemens Healthineers, Erlangen, Germany) reagent strip was then immersed in the urine sample and then analyzed with an automated reading on a Siemens Clinitek status urine analyzer (Siemens Healthineers, Erlangen, Germany). Results were recorded and scanned into the patients' medical records on the day of the flexible cystoscopy. UDH testing was determined to be positive if a result of trace or greater (0.060 mg/dL) was returned. The result of UDH testing was compared to the outcome of histopathological examination of lesions that were detected at the time of flexible cystoscopy.

Standard white light flexible cystoscopy was performed. If suspicious lesions of the bladder mucosal lining were detected at the time of flexible cystoscopy, the patient proceeded to have these biopsied under a general anesthetic (GA). Lesions were determined to be suspicious at clinician discretion at the time of flexible cystoscopy. Our protocol for the surveillance of low-risk non-muscle-invasive bladder included initial cystoscopy at 3 and 12 months and then annually thereafter, provided there are no recurrences (Figure 1). Recurrence was defined as any cancer identified on histopathological review of a biopsy specimen, performed by a dedicated uropathologist. If multiple tumors were biopsied at the same GA cystoscopy, recurrence was determined to have occurred if urothelial cancer was present in any biopsy specimen, while no recurrence occurred if urothelial cancer was not present in any biopsy specimens. Additional urinary biomarkers and blue light fluorescent cystoscopy were not utilized for any patient in this study.



**Figure 1.** (Left): Current follow-up schedule based on the European Association of Urology (EAU) and American Urological Association (AUA) guidelines. (Right): Proposed follow-up schedule incorporating urine dipstick haematuria testing. UDH = urinary dipstick for haematuria. NMIBC = non-muscle-invasive bladder cancer.

Variables collected from the time of initial diagnosis included tumor grade, stage, size, and number. The result of urine dipstick haematuria testing at the time of flexible cystoscopy, time from initial NMIBC diagnosis to cystoscopy, and results of cystoscopy and subsequent biopsy were also collected. A multivariate mixed-effects regression model was utilized to identify confounding patient factors that predict UDH positivity.

Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated on a per-cystoscopy basis. Sensitivity analysis of the diagnostic performance of UDH testing at varying detection thresholds was performed. Exploratory subgroup analysis of diagnostic performance stratified by recurrence and gender and at specified time intervals post initial diagnosis was also undertaken. As data for the presence of haematuria and tumor recurrence were binary, we used the Clopper–Pearson interval to calculate confidence intervals (CI).

Exploratory analysis of the clinical and economic impacts of an algorithm replacing cystoscopy at 24 and 48 months with UDH testing was conducted. Due to the higher risk of NMIBC recurrence in the first 12 months following diagnosis, 24 months was chosen, along with 48 months to allow for a scheduled cystoscopy at 36 months, hence reducing the interval for any delays in recurrence diagnosis. Data were analyzed using SPSS v31 for Mac (IBM, Armonk, NY, USA).

This study was conducted in accordance with the Declaration of Helsinki and ethical approval was obtained through the Central Adelaide Local Health Network Human Research Ethics Committee (REF 20870). A waiver of consent was approved by the ethics committee.

### 3. Results

There were 1597 patients undergoing cystoscopic surveillance for NMIBC during the study period, of which 124 met inclusion criteria. A total of 30 patients were excluded due to history of upper tract urothelial cancer, and 25 patients were excluded due to a diagnosis of non-urothelial bladder cancer. The median age of patients was 77.2 years (range 33.2–97.9 years), and 78% of patients were male. There were 310 surveillance cystoscopies performed (range 1–8 per patient), and 8 cystoscopies were excluded from analysis as no urine dipstick result was recorded. The median duration between the most recent diagnosis of low-risk NMIBC and flexible cystoscopy was 29 months (range 3–239 months). At the time of cystoscopy, 75 (24.2%) cases had a previous recurrence >12 months from the previous diagnosis. The results of mixed-effect multivariate logistic regression analysis showed that female gender was the only variable that predicted higher odds of a positive UDH test result.

Patient demographics and the outcome of multivariate logistic regression analysis, with dipstick positivity as the outcome variable, are presented in Table 1.

**Table 1.** Demographic details, multivariate logistic regression analysis with dipstick positivity as the outcome variable, and patients undergoing surveillance for low-risk non-muscle-invasive bladder cancer.

| Characteristic                                      | Value            | aOR                | <i>p</i> |
|-----------------------------------------------------|------------------|--------------------|----------|
| Median age, years (IQR)                             | 77.0 (65.7–81.7) | 1.01 (0.99–1.03)   | 0.22     |
| Gender (M:F)                                        | 97:27            | 2.20 (1.19–4.06) * | 0.01     |
| Median time since last recurrence, months (IQR)     | 29 (12–53)       | 1.00 (0.99–1.01)   | 0.71     |
| Diabetes mellitus, <i>n</i> (%)                     | 33 (26.6)        | 1.03 (0.56–1.92)   | 0.91     |
| Anticoagulant and/or antiplatelet use, <i>n</i> (%) | 54 (43.5)        | 1.43 (0.81–2.54)   | 0.22     |
| Smoking, <i>n</i> (%)                               |                  |                    |          |
| Never                                               | 51 (41.1)        | -                  | -        |
| Ex                                                  | 44 (35.4)        | 1.27 (0.65–2.50)   | 0.48     |
| Active                                              | 29 (23.4)        | 1.49 (0.78–2.86)   | 0.23     |

\* reference category = male. IQR = interquartile range, aOR = adjusted odds ratio.

Haematuria was detected on dipstick prior to 164 (53%) cystoscopies. Bladder biopsy was undertaken following cystoscopy in 50 (16%) instances, of which 32 (10%) demonstrated malignancy on histopathological examination. In patients with tumor recurrence and a UDH negative result ( $n = 6$ ), five tumors were low-grade, and there was one papillary urothelial neoplasm of uncertain malignant potential (PUNLMP). All episodes of high-grade ( $n = 1$ ) or carcinoma-in-situ ( $n = 1$ ) tumors were UDH positive.

The overall NPV and sensitivity for UDH testing using a threshold of trace were 95.6% and 81.3%, respectively. As demonstrated in Table 2, as the detection threshold increased, the sensitivity and NPV of the test decreased, and conversely, the specificity and PPV increased.

**Table 2.** Sensitivity analysis of diagnostic performance of urinary dipstick for haematuria (UDH) testing at various levels of haematuria detection.

|          | Sensitivity | 95% CI    | Specificity | 95% CI    | NPV  | 95% CI    | PPV  | 95% CI    |
|----------|-------------|-----------|-------------|-----------|------|-----------|------|-----------|
| Trace    | 81.2        | 63.6–92.8 | 48.9        | 42.8–55.0 | 95.7 | 91.4–97.9 | 15.8 | 13.3–18.8 |
| Small    | 40.6        | 23.7–59.4 | 87.1        | 82.5–90.8 | 92.5 | 90.3–94.3 | 27.1 | 18.1–38.5 |
| Moderate | 15.6        | 5.3–32.8  | 95.9        | 92.8–98.0 | 90.6 | 89.2–91.8 | 31.2 | 14.4–55.1 |

CI = confidence interval, NPV = negative predictive value, PPV = positive predictive value.

Exploratory analyses of subgroups demonstrated that the NPV and sensitivity of patients within 12 months of the most recent diagnosis were 95.4% and 83.3%, respectively, and after 12 months since diagnosis, 96.4% and 80%, respectively. The sensitivity for patients with and without prior recurrence was 85.7% and 80%, respectively. NPV, PPV, specificity and sensitivity at varying time intervals post diagnosis, and stratification by gender are demonstrated in Table 3. Raw results for dipstick results stratified by recurrence status are demonstrated in Table S1.

**Table 3.** Exploratory subgroup analyses of diagnostic performance of urinary dipstick for haematuria (UDH) testing for bladder cancer recurrence stratified by time since diagnosis and recurrence status.

|                      | Sensitivity | 95% CI    | Specificity | 95% CI    | NPV  | 95% CI    | PPV  | 95% CI    |
|----------------------|-------------|-----------|-------------|-----------|------|-----------|------|-----------|
| Overall              | 81.3        | 63.6–92.8 | 48.9        | 42.9–55.0 | 95.7 | 91.4–97.9 | 15.8 | 13.3–18.8 |
| Gender               |             |           |             |           |      |           |      |           |
| Male                 | 77.3        | 54.6–92.2 | 54.4        | 47.3–61.4 | 95.7 | 91.1–98.0 | 15.5 | 12.2–19.4 |
| Female               | 90.0        | 55.5–99.8 | 31.8        | 20.9–44.4 | 95.5 | 76.0–99.3 | 16.7 | 13.3–20.7 |
| Recurrence           |             |           |             |           |      |           |      |           |
| Yes                  | 85.7        | 42.1–99.6 | 47.0        | 34.6–59.7 | 96.9 | 83.2–99.5 | 14.6 | 10.5–20.0 |
| No                   | 80.0        | 59.3–91.7 | 49.5        | 42.5–56.7 | 95.3 | 90.1–97.8 | 16.3 | 13.3–19.8 |
| Time Since Diagnosis |             |           |             |           |      |           |      |           |
| <12 months           | 83.3        | 51.6–97.9 | 56.2        | 44.1–67.8 | 95.4 | 85.1–98.7 | 23.8 | 17.9–31.0 |
| >12 months           | 80.0        | 56.3–94.3 | 53.8        | 46.6–60.9 | 96.4 | 91.6–98.5 | 15.0 | 11.9–18.7 |
| <5 years *           | 80.7        | 62.5–92.6 | 51.4        | 44.5–58.3 | 94.8 | 89.7–97.4 | 19.5 | 16.3–23.2 |

CI = confidence interval, NPV = negative predictive value, PPV = positive predictive value. \* diagnostic performance beyond 5 years from diagnosis is not presented due to low event counts in this cohort. Detection threshold used = trace.

At 24 months post-diagnosis surveillance cystoscopy, seven total recurrences were identified, all of which were LGTa. Exploratory analysis of performing UDH testing in lieu of cystoscopy at 24 months post-diagnosis demonstrated that two of these seven diagnoses of LGTa bladder would have been delayed, and 21 cystoscopies avoided. At 48 months, five recurrences were identified. In addition, one diagnosis of LGTa and one of PUNLMP would have been delayed if UDH had been performed in lieu of cystoscopy,

and 24 cystoscopies would have been avoided. If all cystoscopies performed more than 5 years after diagnosis had been avoided and replaced with UDH testing, 23 cystoscopies would have been avoided, and no recurrences would have been missed or their diagnosis delayed.

Using the National Health Service (NHS) reference costs for flexible cystoscopy of GBP 449 and for urine dipstick testing of GBP 3.85, this could lead to a saving of GBP 445.15 per avoided cystoscopy [3,9]. This would result in a saving of GBP 20,031 for cystoscopies performed in the first 5 years of surveillance in our institution's small cohort in cystoscopy cost alone. This limited economic analysis does not account for costs related to administration, potential delays in recurrence diagnosis or, conversely, costs associated with false positive flexible cystoscopies resulting in biopsy of benign lesions under GA.

#### 4. Discussion

This is the second study, and the first in the Australian setting, to explore the role of urine dipstick haematuria in the surveillance of NMIBC. This study demonstrated that there is a high probability of a UDH negative result being associated with the absence of recurrence in low-risk NMIBC surveillance. All recurrences that were not identified by UDH testing were low-grade pTa or PUNLMP. Female sex was predictive of a UDH positive result, which is consistent with the literature, and high NPV was identified for both genders [10]. When interpreting these findings, it should be noted that the relatively low prevalence of recurrence of NMIBC influences the NPV, and at baseline, a high NPV is to be expected in any NMIBC surveillance cohort.

Due to the high incidence of microscopic haematuria in the general public, which is estimated to be up to 31%, UDH testing will always have poor PPV and specificity [11]. However, the intended use case of UDH testing in this context is to identify cystoscopies that can be safely avoided whilst aiming to miss minimal cases of recurrence; therefore, NPV and sensitivity are the most important metrics. Sensitivity analysis demonstrated that as the detection threshold for haematuria increased, the NPV and sensitivity decreased and PPV and specificity increased. Given this, our preferred detection threshold is the lowest level of 'trace', as this provides the greatest sensitivity and NPV.

To our knowledge, only two previous studies have evaluated the diagnostic performance of UDH in the surveillance of NMIBC [12]. In Park et al.'s retrospective analysis of 584 patients with low-grade (2004 World Health Organization [WHO] Classification) NMIBC, microscopic haematuria on urinalysis was associated with increased odds of recurrence (odds ratio [OR] 1.57, 95% CI 1.11–2.22,  $p = 0.011$ ) [13]. In their two-stage prospective study of 532 patients with low- or intermediate-risk NMIBC, Shah et al. reported an overall negative predictive value of 90% in both cohorts [12]. In their study, a detection threshold of 'small' was used, with poor sensitivity (42% exploratory, 10% validation cohorts) corresponding with the sensitivity analysis in our study. As outlined above, given the improved sensitivity with a detection threshold of trace, this is our preferred threshold. Unfortunately, an analysis of different detection thresholds was not presented in Shah et al.'s study, preventing comparison.

Alternative methods of cystoscopic surveillance that have been investigated include urinary biomarkers and urine cytology. The poor sensitivity of urine cytology in low-grade disease is well established, and for this reason it is not recommended for use in low-risk cohorts [1,14]. Urinary biomarkers, while promising for high-grade disease surveillance, face similar challenges in low-grade tumors, where sensitivity ranges from only 35–65% [15–19]. The recent Urofollow trial was the first trial to investigate the use of urinary markers specifically in the follow-up of low and intermediate-risk patients [20]. The algorithm-based follow-up found an overall sensitivity of 81.5% for recurrence, with

individual markers' sensitivity ranging from 19 to 80%. The results of our investigation and Shah et al.'s study demonstrate that UDH testing may achieve equivalent sensitivity to that of more expensive urinary biomarkers in a low-risk follow-up cohort. Importantly, UDH testing offers distinct advantages over both urinary biomarkers and cystoscopy including lower cost, greater accessibility, and ease of use, positioning it as an ideal tool for use in low-resource healthcare settings.

For patients with low-risk NMIBC who have remained recurrence-free for more than 5 years, recent updates to international guidelines have recommended consideration of discontinuing routine cystoscopic surveillance [1,2]. This recommendation is made due to the low probability of clinically significant recurrence more than 5 years after diagnosis [21]. Regardless, some patients and clinicians remain reluctant to cease follow-up altogether due to concerns about late recurrence. In this context, UDH testing may represent a pragmatic, non-invasive alternative for ongoing monitoring beyond the 5-year mark. The overall high NPV and sensitivity of UDH testing for recurrence, as well as the test's low cost and ease of use, may make it a potential tool to provide ongoing reassurance to both patients and clinicians without incurring the burden of indefinite cystoscopic surveillance. The low recurrence rate beyond 5 years in this study prevents meaningful analysis of this sub-cohort specifically; however, we would not expect the diagnostic utility of UDH testing to differ substantially in this group.

Bladder cancer is estimated to have one of the highest lifetime economic burdens among all cancers, primarily due to its time- and resource-intensive cystoscopic surveillance regimens [6]. Our exploratory analysis showed that replacing cystoscopy with UDH testing at 24 and 48 months would have avoided 53 cystoscopies; however, it would have delayed the diagnosis of four low-grade recurrences. Similar figures were seen in Shah et al.'s analysis, with 25% of patients in the validation cohort avoiding cystoscopy at the expense of four delayed diagnoses of low-grade Ta recurrence. The potential healthcare cost savings from reduced cystoscopy utilization, combined with improved patient comfort and administrative burden, support further investigation of surveillance algorithms incorporating UDH testing. We are aware of plans to implement such an algorithm into Scottish national surveillance protocols, with validation data pending [22].

There are obvious downsides to the incorporation of UDH testing, or any other biomarker, into surveillance strategies. The test is not 100% accurate, which unfortunately leads to delays in the diagnosis of recurrence. To our knowledge there is no published literature investigating the economic impact of a 12-month delay in low-risk NMIBC recurrence. However, the foreseeable impact would include longer transurethral resection of bladder tumor (TURBT) time and post-operative stay, potential emergency presentations, and a 0.06% risk of progression [23]. Additionally, although it is intended to be an alternative to cystoscopic surveillance beyond 5 years, it is foreseeable that some patients would choose to have UDH testing at this stage, when they would have otherwise chosen to cease surveillance entirely. This could lead to patient anxiety when positive results ensue and potentially result in cystoscopies that otherwise would not have occurred.

This study is limited by several factors. This was a retrospective study and is therefore prone to the biases and limitations of studies of this type. However, we are confident that all patients undergoing surveillance for low-risk NMIBC at our institution were captured. Secondly, our small cohort size of 124 patients reduces the precision of our findings, as demonstrated by the wide confidence intervals. This is particularly relevant when assessing sub-cohorts, such as recurrences beyond 5 years, and the findings of this study should be interpreted with this in mind. Additionally, our study was limited to patients with low-risk disease at the time of surveillance, and these results may not be generalizable to intermediate or high-risk cohorts. It should be noted that disease prevalence directly

impacts predictive values due to the low prevalence of recurrence in low-risk NMIBC cohorts; the proportion of true negative results is high at baseline. This may inflate the NPV and result in overestimation of a test's ability to exclude disease.

Lastly, UDH testing was unable to be combined with other urinary biomarkers to develop more sophisticated algorithms for reduction in cystoscopic surveillance frequency. Given these limitations, further blinded prospective studies with larger, diversified patient populations are necessary to validate these findings and establish the broader clinical utility of UDH testing assessment in NMIBC surveillance.

## 5. Conclusions

This study demonstrates that UDH testing achieves high negative predictive value and sensitivity for detecting bladder cancer recurrence in patients undergoing surveillance for low-risk NMIBC. These findings suggest UDH testing shows promise as an adjunct tool to reduce cystoscopic surveillance frequency in selected populations. Additionally, UDH testing may have utility for patients who wish to undergo surveillance beyond 5 years from diagnosis. Larger prospective studies are needed to validate these preliminary findings and establish definitive clinical practice guidelines, including the incorporation of UDH testing with other urinary biomarkers in the surveillance setting.

**Supplementary Materials:** The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/siuj7010006/s1>, Table S1: 2 × 2 tables of dipstick result according to recurrence status.

**Author Contributions:** Conceptualization, S.H. and D.N.; methodology, D.N. and T.M.; software, D.N.; formal analysis, D.N. data curation, D.N., T.M., and G.M.; writing—original draft preparation, D.N.; writing—review and editing, D.N. and S.H.; supervision, S.H. All authors have read and agreed to the published version of the manuscript.

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**Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Central Adelaide Local Health Network (protocol code REF 20870, 15 August 2024).

**Informed Consent Statement:** Patient consent was waived due to the retrospective nature of this study. Waiver of consent was approved by our local human research ethics committee in accordance with the requirements of Section 2.3.10 of the National Statement on Ethical Conduct in Human Research 2023.

**Data Availability Statement:** The datasets generated and analyzed during this study are available at request from the corresponding author. Due to patient confidentiality, individual participant data cannot be shared publicly, but de-identified data may be available upon reasonable request to the corresponding author.

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

## Abbreviations

The following abbreviations are used in this manuscript:

|       |                                    |
|-------|------------------------------------|
| NMIBC | Non-muscle-invasive bladder cancer |
| LG    | Low-grade                          |
| UDH   | Urine dipstick haematuria          |
| GBP   | Great British Pound                |
| USD   | United States Dollar               |
| CI    | Confidence interval                |
| NPV   | Negative predictive value          |

|       |                                          |
|-------|------------------------------------------|
| PPV   | Positive predictive value                |
| NHS   | National Health Service                  |
| WHO   | World Health Organization                |
| OR    | Odds ratio                               |
| TURBT | Transurethral resection of bladder tumor |

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